MACHINERY
JANUARY 25, 1961 ONE SHILLING & THREEPENCE

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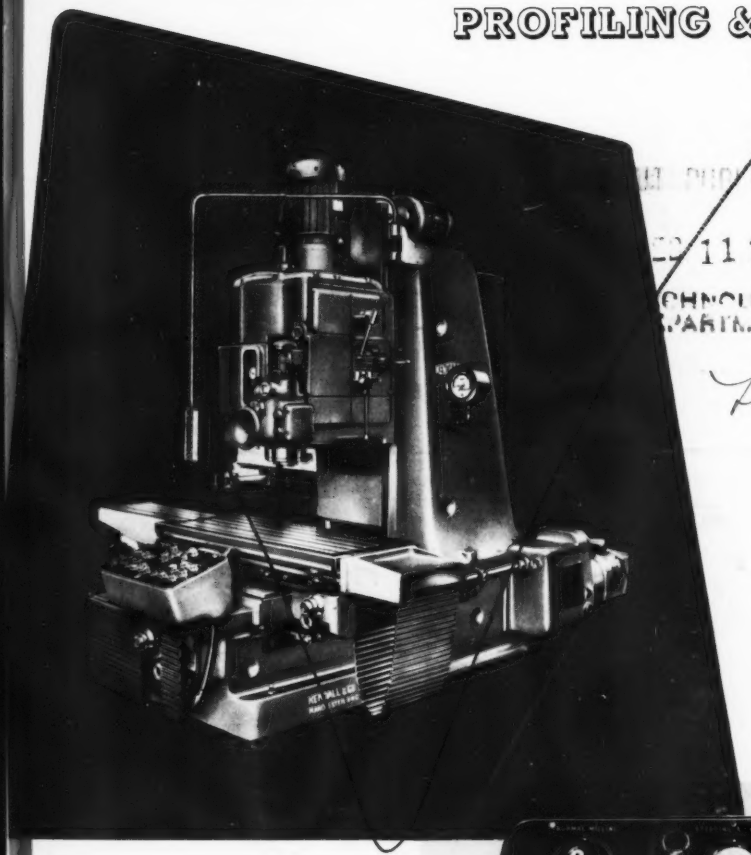
TECHNOLOGY
DEPARTMENT

PROFILING & STEERING CONTROL ON THE CVM15 TWO-DIMENSIONAL COPY-MILLING MACHINE



These most recent additions to our range of C.V.M. Vertical Milling Machines have passed all tests with flying colours and are now available for early delivery.

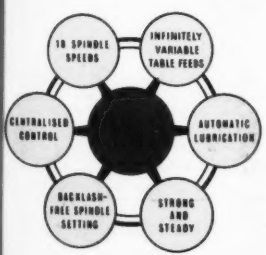
COPY MILLING

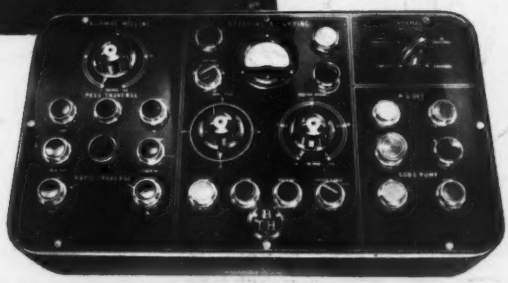
Copy milling of two-dimensional contours is achieved through automatic electronic control of the table traverses. This technique is applicable to workpieces within the capacity of the machine table.

STEERING

When milling complicated shapes simultaneous control of longitudinal and transverse table feeds allows direction of travel of the cutter in relation to the work to be "Steered" through 360 degrees. This increases cutting efficiency by eliminating idle traversing of the table.

Working surface of table	54in. x 16in.
Spindle Nose to Table	Min. 1¼in. Max. 24in.
Spindle Driving Motor	10hp.
Spindle Speeds	up to 1600 rpm
Table Feeds	up to 48 ipm
Table Rapid Traverse	72 ipm





KENDALL & GENT LTD
GORTON MANCHESTER
Phone EAST 1035

ASSOCIATION OF MACHINE TOOL MERCHANTS ABMTM LTD

BRAYSHAW
TOOLS LIMITED
BELLE VUE WORKS,
MANCHESTER 12.
Phone: EASt 1046 (3 Lines)
Grams: Hardening M C.

HiFEED serrated heavy duty cutters are designed to provide a combination of high rate of stock removal and good surface finish.

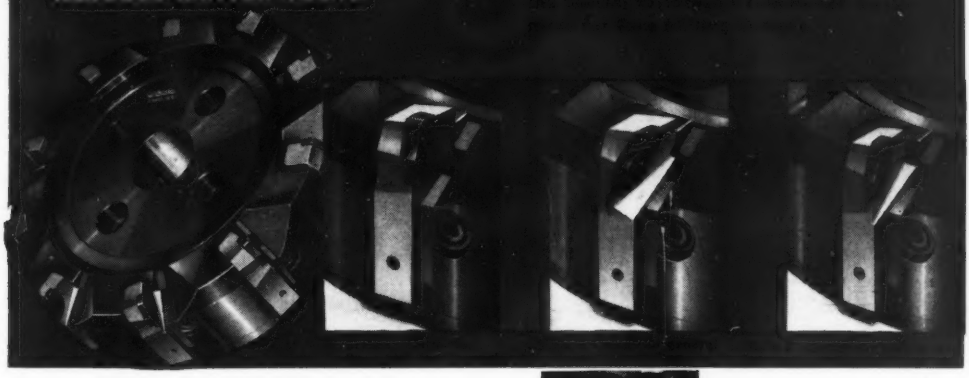
Some of the advantages to be obtained are:—
SINGLE POINT CUTTING EFFICIENCY.
REDUCED LOAD AND VIBRATION on machine and work.
INCREASED PRODUCTION, particularly on work hardening and high tensile materials.
EFFICIENT HEAT DISSIPATION resulting from the break up of the cutting edges enables **HIGHER FEEDS AND SPEEDS** to be employed.

Primarily designed for heavy stock removal HiFEED cutters produce a surface finish acceptable for most applications. An alternative design, offering similar advantages plus superior surface finish when required, is also available.
HiFEED cutters INCREASE production REDUCE costs.
Send to-day for your copy of leaflet S.T.603.

H.A.P.'s
TRADE SERVICE
BROACHING SPLINING & GEAR CUTTING
now includes the Generation of
PRECISION RACKS
INDLE UTO RODUCTS LTD
HAPCO WORKS · CALEDONIA STREET · BRADFORD 5
Phone: BRADFORD 27234-5-6 Grams: HAPCO BRADFORD

RAPID RE-SET
Face Milling Cutters

Secure ——
RAPID BLADE RE-SETTING
RAPID RE-SERVICING
REDUCED CUTTER DOWN TIME
REDUCED CUTTER COSTS



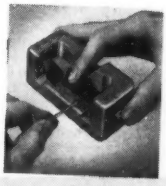
RAPID RE-SET EQUIPMENT

The use of the Wickman Rapid Re-set Cutter Body and three blade styles available provides a simple variation of blade geometry. The blades can be removed, re-ground, checked and replaced in any Cutter Body size within the range—WITHOUT REMOVING THE CUTTER BODY FROM THE MACHINE, thus reducing down times and costs to a minimum.

WRITE FOR YOUR COPY OF THE NEW WICKMAN FOLDER "WICKMAN RAPID RE-SET FACE MILLING CUTTERS" FOR THE FULL STORY.

GRIND—with special jig

GAUGE—for accuracy



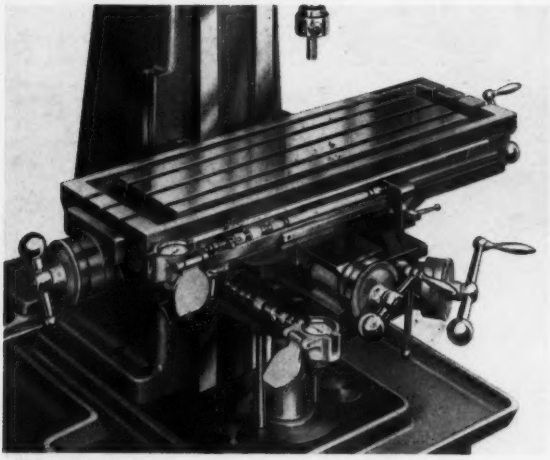
RE-SET—in setting block

WICKMAN LIMITED
WIMET DIVISION, TORRINGTON AVENUE, COVENTRY. Telephone 66621

552 ST

HAYES DIEMASTER

PRECISION VERTICAL MILLING MACHINE



Jig Boring Equipment

HARDENED AND GROUND THREAD LEAD SCREWS NOW STANDARD EQUIPMENT

	HM 21 A	HMH 26 A with Hydraulic Copying
Table size	21" × 6½"	26" × 8¾"
TRAVERSE DIMENSIONS		
Table (Longitudinal) ...	12"	13"
Underslide (Lateral) ...	5"	5"
Knee (Vertical) with Vertical Milling Head ...	13¼"	13¼"
Knee (Vertical) with Horizontal Milling Head	16"	16"
Hydraulic Vertical Traverse	—	2½"
Maximum Height under Spindle Nose	13½"	13½"
Overarm Traverse ...	7½"	7½"
Working Area	12" × 12"	12" × 13"
9 Spindle Speeds	50-2,400 r.p.m.	50-2,400 r.p.m.

ADDITIONAL EQUIPMENT

High Speed Milling Head. 6 Spindle Speeds 1,000 to 6,000 r.p.m.
Horizontal Milling Heads. Jig Boring Equipment. 8" and 11" diameter Rotary Tables.

Diemaster HM 21 A

Hayes LEEDS

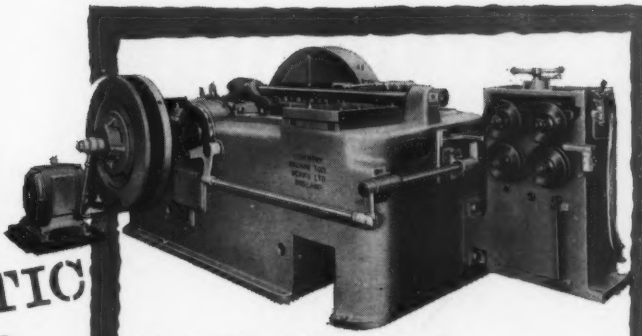
HAYES ENGINEERS (LEEDS) LTD.

GELDERD ROAD, LEEDS 12
Tel.: 30941. 'Grams: "Toolmaker" Leeds 12.

Sole Selling Agents for Home and Overseas:—
ASSOCIATED BRITISH MACHINE TOOL MAKERS LTD.
17 GROSVENOR GARDENS, LONDON, S.W.1.

COVMAC

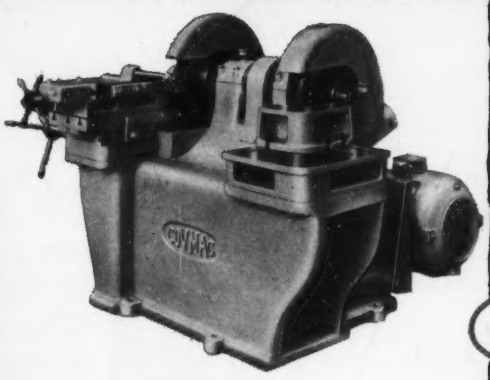
AUTOMATIC FORGER



No. 2 machine with guards removed.

The stock is placed between the rolls and is then fed through the dies to the workstop. The die then closes, cutting off the stock to the required length, and delivers it to the heading position. The heading tool then completes the forging, which falls down the chute and is taken away by conveyor.

The Automatic Forger can be supplied in several sizes and for making balls of up to and including 4in. diameter.



No. 3 machine illustrated.

These machines are made in three sizes. The smallest handles bars up to 2in. diameter. The largest size, as illustrated, takes bars up to 4in. diameter. They are an invaluable asset to any forging or drop stamping plant. We also make nine sizes of Standard Upsetting Machines to take bars from ¾in. to 6in. diameter.

COVMAC

HOT MILLER

COVENTRY MACHINE TOOL WORKS LTD

GRANTHAM RD. HALIFAX ENGLAND

Phone: Halifax 3234/5 Grams: Covmac Halifax

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MASTER GAUGEMAKERS

ADJUSTABLE THREAD

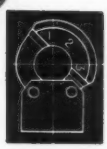
CALIPER GAUGES

Standard sizes—Ex Stock.
Special sizes quickly delivered.
Sizes—12BA—12in. dia.
Bench stands and sealing tools available.
Prompt re-grinding and re-setting service.

A.I.D. release or certificates of examination if required.

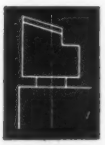
Approved A.I.D. Test House (M.O.S. Authority S795/52)

TOOL MAKERS' GAUGE ASSOCIATION



TYPE A
Cylindrical non - rotating anvils.

TYPE E
Roller rotating anvils.



TYPE D
Flat 'Matrix' anvils.

TOLIMIT · GAUGES · LIMITED

VICTORIA ROAD BURGESS HILL, SUSSEX. 'Phone: Burgess Hill 2718.

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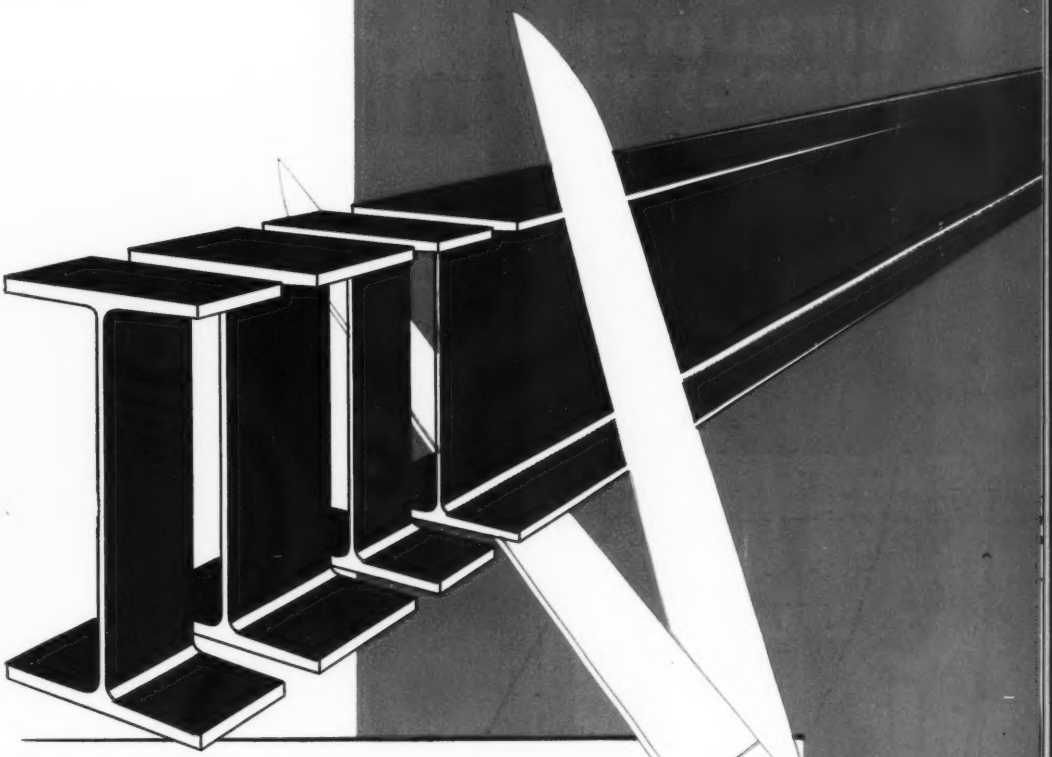


Yet another cut
IN COST OF STEELWORK

A recent amendment to the British Standard* provides a simplified method of taking into account the restraining effect of the normal beam-to-stanchion connections.

This further saving in steel is well worth while.

**Amendment No.1 PD 3857 29 July 1960 to BS.449.1959*

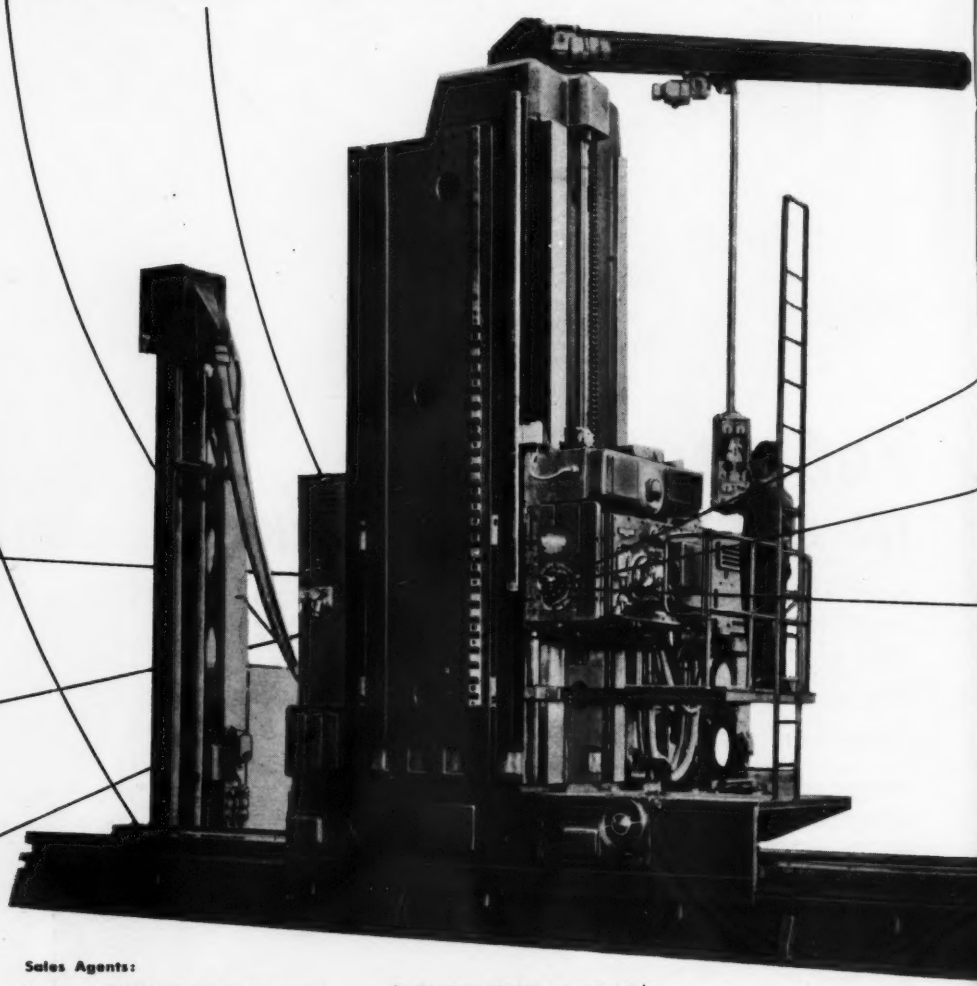
BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION
ARTILLERY HOUSE, ARTILLERY ROW,
WESTMINSTER, S.W.1

B·C·S·A

MITSUBISHI INNOCENTI CWB

milling boring

MITSUBISHI ZOSEN KABUSHIKI KAISHA (Mitsubishi Shipbuilding & Engineering Co., Ltd.) take pleasure in announcing the conclusion of a license agreement with INNOCENTI S.G. Milano for the manufacture and world-wide distribution of the universally known INNOCENTI-CWB MILLING, BORING & COMBINED MACHINES. The machines will be produced in Floor Type, Planer Type and other Combination Types, the diameters of spindles being 140 mm for milling and 95 mm for boring.



Sales Agents:

London: Mitsubishi Shoji Kaisha, Ltd., London Branch, Bow Bell House, Bread Street, London

New York: Mitsubishi International Corp., 120 Broadway, New York 5, N.Y.

Los Angeles: Mitsubishi International Corp., 606 South Hill St., Los Angeles 14, Calif.

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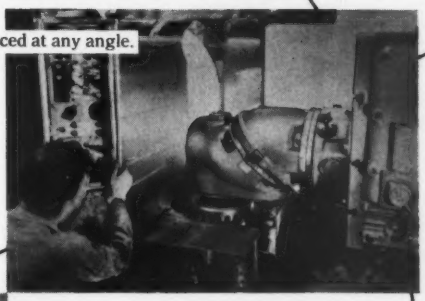
Paris: Mitsubishi France (SARL), 9, Rue Scribe, Paris

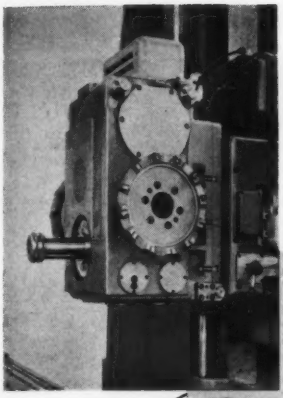
Düsseldorf: Deutsche Mitsubishi Export & Import-Gesellschaft m.b.H., 12 Grünstrasse Düsseldorf

Melbourne: Mitsubishi (Australia) Pty. Ltd., Melbourne Office, 1st Floor, Haughton House, 543 Little Collins St., Melbourne, C. 1, Victoria

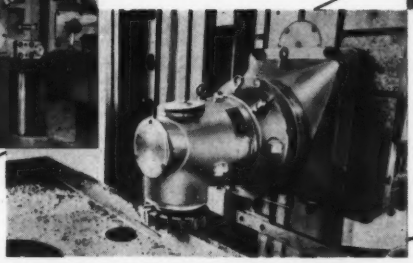
and combined machines

Universal head : Can be placed at any angle.



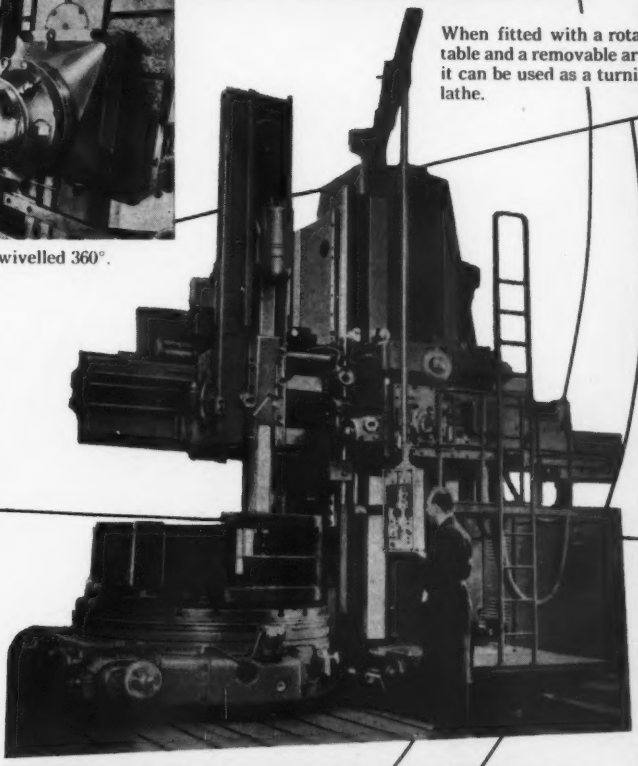


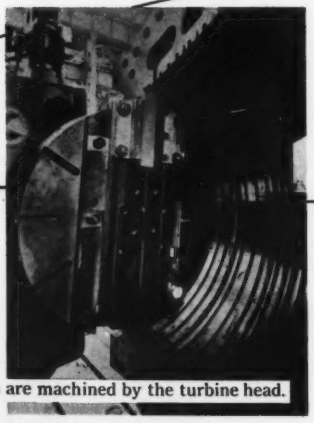
Milling can be done on three faces by the three way head.



Right-angle head : Can be swivelled 360°.

When fitted with a rotar table and a removable arr it can be used as a turnin lathe.





Grooves are machined by the turbine head.

MITSUBISHI ZOSEN

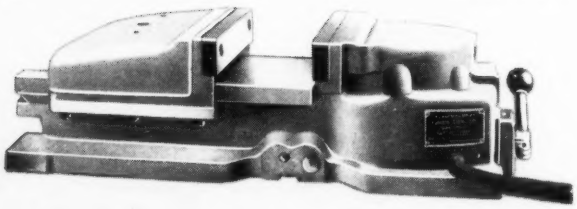
(MITSUBISHI SHIPBUILDING & ENGINEERING CO. LTD)

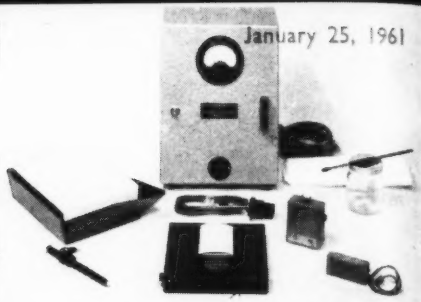
Head Office: Marunouchi, Tokyo, Japan

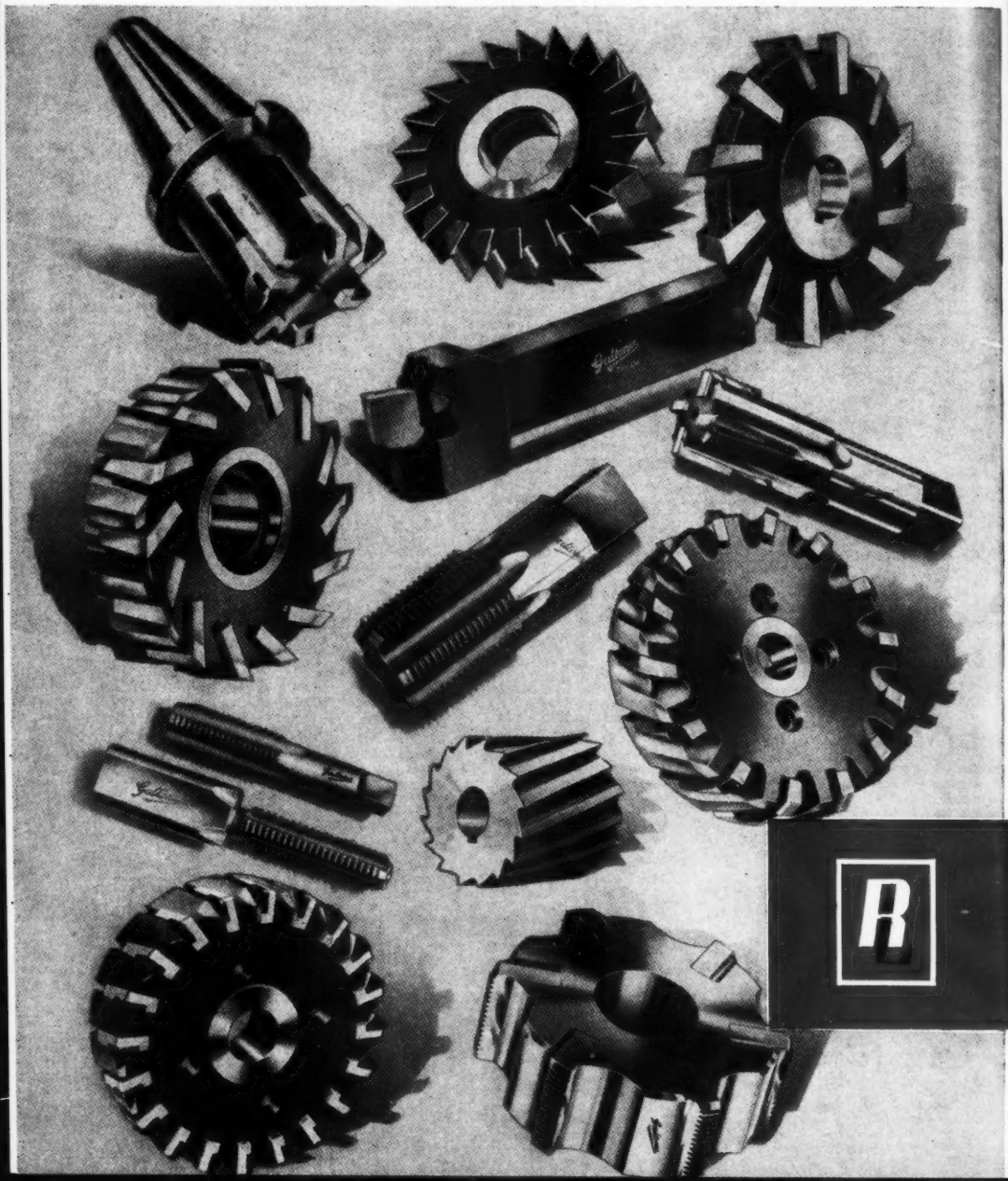
Machine Tool Manufacturing Division:

HIROSHIMA PRECISION MACHINE WORKS

Hiroshima, Japan



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Galtona
TRADE MARK

SERRATED BLADE CUTTERS

Economical, adjustable and adaptable, the wide range of types and sizes caters for all requirements. Reasonable in initial cost, they are economical in use since the blades are adjustable to maintain size when regrinding and are replaceable when necessary. Supplied in high speed steel, super Cobalt "Stellite" or cemented carbide tipped. Special tools can be designed for individual needs. Our Cutting Tool Engineers will consult with you on your tooling problems.

GROUND THREAD TAPS

Unexcelled for accuracy and performance Galtona Ground Form Relieved Taps are thread ground from the solid after hardening. Supplied in all thread forms to B.S. or special tolerances. Large stocks are maintained of standard sizes in all popular thread forms. Specials made to order. Our Tap Engineers are available for consultation on individual problems.

PNEUMATIC MACHINE VICE

Provides instantaneous grip and release giving considerable increase in production speeds. Rigid and robust construction; air valve mechanism housed in main body casting. Gives constant pressure of 1¾ tons in any gripping position with line pressure of 80 lbs. per sq. inch.

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The range comprises all types of Milling Cutters both standard and special including form relieved.

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For Lathes, Shapers, Planers and Boring Mills. In front and rear lock styles made from nickel chromium heat treated steel. Nineteen shapes of tool bit available in standard H.S. Steel and in our T.15 H.S. Steel for more difficult materials. Also stocked carbide tipped for steel and cast iron.

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GEARS FOR

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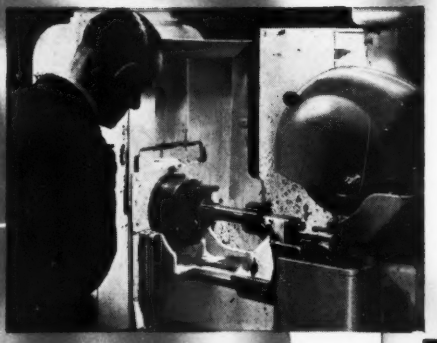
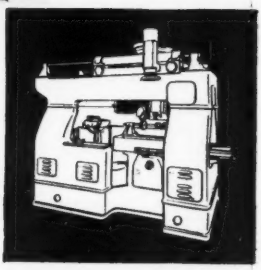
The gears on a heavy SCAMMEL vehicle have to be tough as they come as well as accurate to a degree for the punishing duty they will have to perform.

The gears shown above are manufactured and tooth ground for SCAMMEL at our Shirley works and the photograph below shows a gear in position on an Orcutt Spur Tooth Gear Grinding machine.

Send us your enquiries.



Comprehensive Gear Grinding Service
Gear Manufactured and Ground Complete
Makers of The Orcutt Range of Gear and Spline Grinding Machines



The Gear Grinding Co. Ltd.

CRANMORE BOULEVARD - SHIRLEY - SOLIHULL - WARWICKSHIRE

Telephone : SHIrley 2231 (6 lines) Telegrams : Orcutt, Birmingham

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WHERE EFFICIENCY COUNTS

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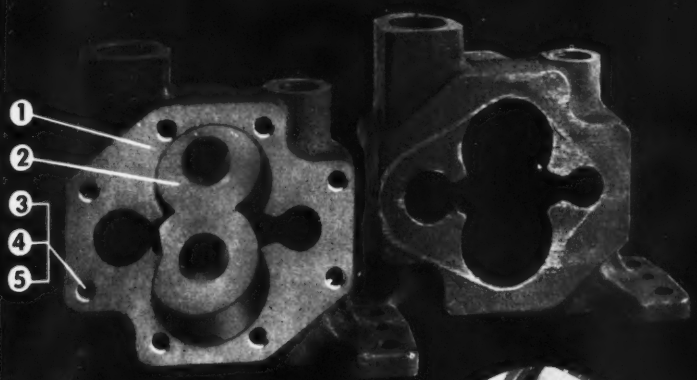

SPECIAL MACHINE
FOR ROUGHING OF CAST IRON
PUMP HOUSINGS
(3 SIZES OF COMPONENTS)

OPERATIONS:
1 FACE MILLING
2 STEP DRILLING
3 DRILLING 8 HOLES
4 COUNTERSINKING 8 HOLES
5 TAPPING

HYDRAULIC CLAMPING

AUTOMATIC WORKING CYCLES
(elektro-hydr. controlled)

FLOOR TO FLOOR TIME: 5.8 min

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SALES-OFFICE:

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WILMSLOW CHESHIRE

Telephone Wilmslow 5344/5/6
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TORQUE-CONVERTER SLEEVE in 'Lemax' heat-treated Pearlitic malleable iron (Weight 27·5lb.)

SPECIFICATION: MINIMUM TENSILE STRENGTH 80,000 LB. SQ. IN. MIN. YIELD POINT 60,000 LB. SQ. IN. MIN. ELONGATION IN 2", 3%

This component plays an important part in the torque converter of a machine of international repute.

As will be seen from the sectional drawing and the photograph, the sleeve embodies ducts for the hydraulic fluid, and is extensively machined. 'Lemax' heat-treated pearlitic malleables have versatile attributes, the ability to cast cored ducts of three-dimensional curvature, in combination with great mechanical strength, adequate shock resistance and the requisite degree of hardness.

LEY'S MALLEABLE CASTINGS COMPANY LIMITED
DERBY, ENGLAND

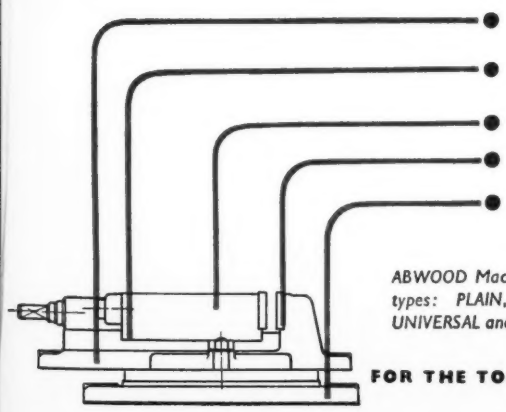
TELEPHONE: DERBY 45671

Regd. Trade Marks:
'Black Heart', 'Leys', 'Lepaz', 'Lemax'

LEY'S

THE VICE

with all the virtues



- V SLIDES ADJUSTABLE FOR WEAR. LONG BEARING SURFACES. IMPOSSIBLE FOR THE JAW TO LIFT AND TILT THE JOB.
- TOTALLY ENCLOSED HARDENED SQUARE THREAD SCREW WHICH CANNOT BECOME SEIZED OR BRUISED.
- SLIDING JAW MACHINED OVER ITS WHOLE SURFACE FOR THE USE OF THE SCRIBING BLOCK.
- GROUND TOOL STEEL JAWS AND PHOSPHOR BRONZE NUT.
- ACCURATELY MACHINE DIVIDED SWIVEL BASES INDEXED FULLY THROUGH 360°.

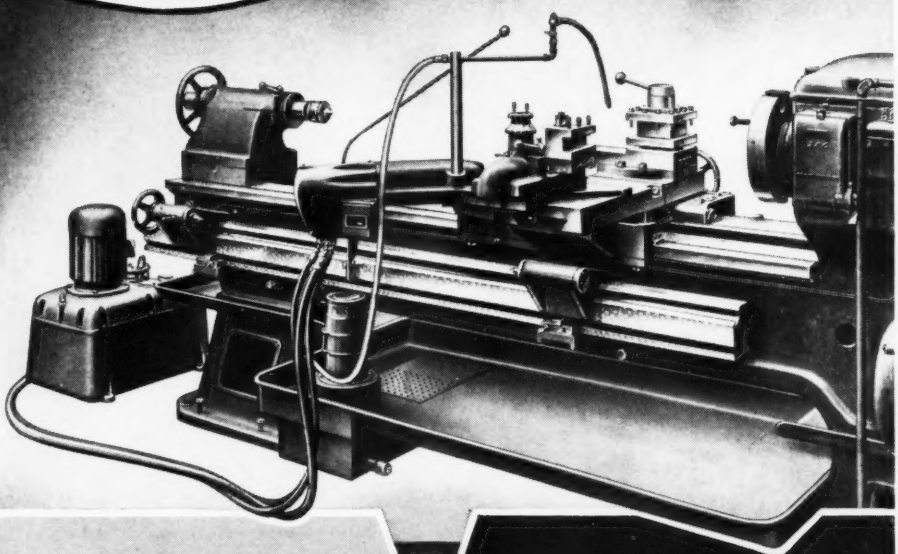
ABWOOD Machine Vices are available in the following types: PLAIN, SWIVEL TYPE (illustrated), SHAPER, UNIVERSAL and UNIVERSAL COMPOUND ANGLE TABLE.

FOR THE TOOLROOM & PRODUCTION

ABWOOD

ABWOOD MACHINE TOOLS LIMITED

CROWTHORN



HYDRAULIC COPYING ATTACHMENT

This extremely useful attachment is suitable for all Crowthorn Lathes. (The illustration shows the unit fitted to a 10½in. Centre Lathe).

Particular advantages of the Crowthorn attachment are as follows:-

1. great reduction in machining times.
2. accuracy does not depend on the skill of the operator.
3. attachment is fitted to existing cross slide at rear of lathe. Front tool post can be used in normal way.
4. round models or flat templates can be used as masters.
5. can be used for boring, face copying and normal external machining.
6. a high degree of accuracy is obtained.
7. slow tapers can be machined and radiused forms easily copied.

CROWTHORN ENGINEERING COMPANY LIMITED

Makers of High Class Machine Tools for over half a century

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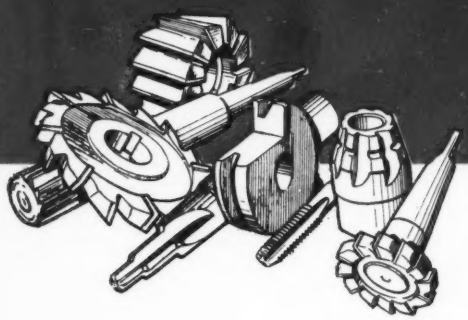

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The illustrations show the boring of a location pin hole in a fuel pump assembly fixture at the premises of Messrs. AC-Delco, Liverpool, by whose courtesy the photographs are reproduced.

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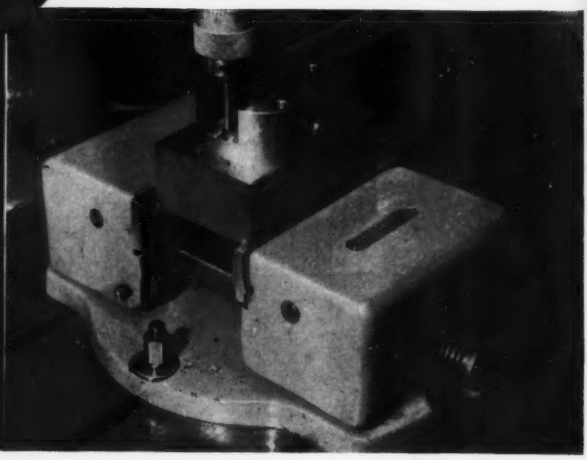

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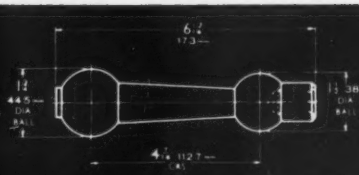

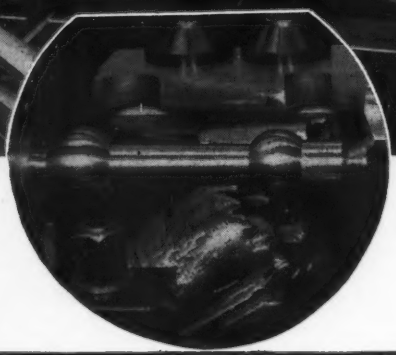

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1¾" dia. 25 ton Tensile Steel E.N.I.A. Tungsten Carbide & High Speed Steel Cutting Tools

Floor to Floor Time : 2 mins. 45 secs.

DESCRIPTION OF OPERATION	Tool Position		Spindle Speed R.P.M.	Max. Cutting Speed		Feed	
	Hex. Turret	Cross-slide		Feet per min.	Metres per min.	Cuts per inch	m/m. per rev.
1. Feed bar to stop, close chuck & centre drill	1	—	955	—	—	Hand	Hand
2. Multiple turn two dias. & end	2	—	955	437	133	125	·203
3. Drill tapping size hole	3	—	955	137	41·7	125	·203
4. Cone bore	4	—	260	43	13·1	Hand	Hand
5. Support with centre & form	5	Rear	260/100	119/46	36·2/14	Hand	Hand
6. Tap $\frac{5}{8}$"×14 t.p.i.	6	—	635	104	31·6	—	—
7. Tangential part off	—	Front	1650	757	230	Hand	Hand

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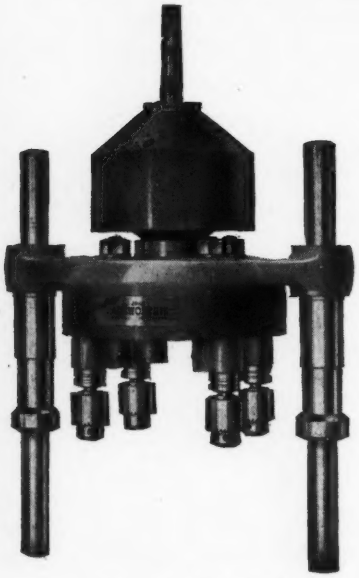

Fig. 100. 4 Spindle Adjustable centres Tapping Attachment. Infinite variations available with fixed or adjustable Spindles.

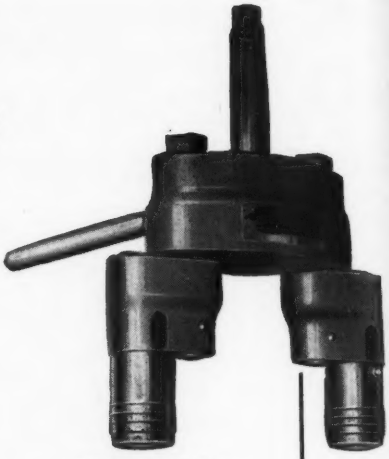

Fig. 199. Adjustable 2 Spindle Attachment.

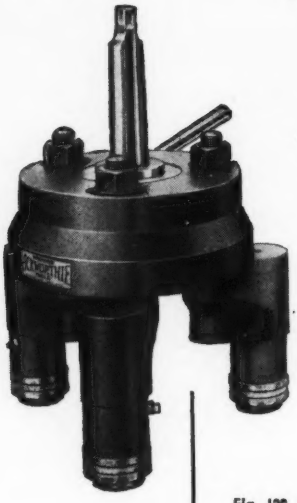

Fig. 199. Adjustable 3 Spindle Attachment.

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Feeds (40) ⅜" to 11" per min. Table traverse 19". Table size 16¼" x 10".

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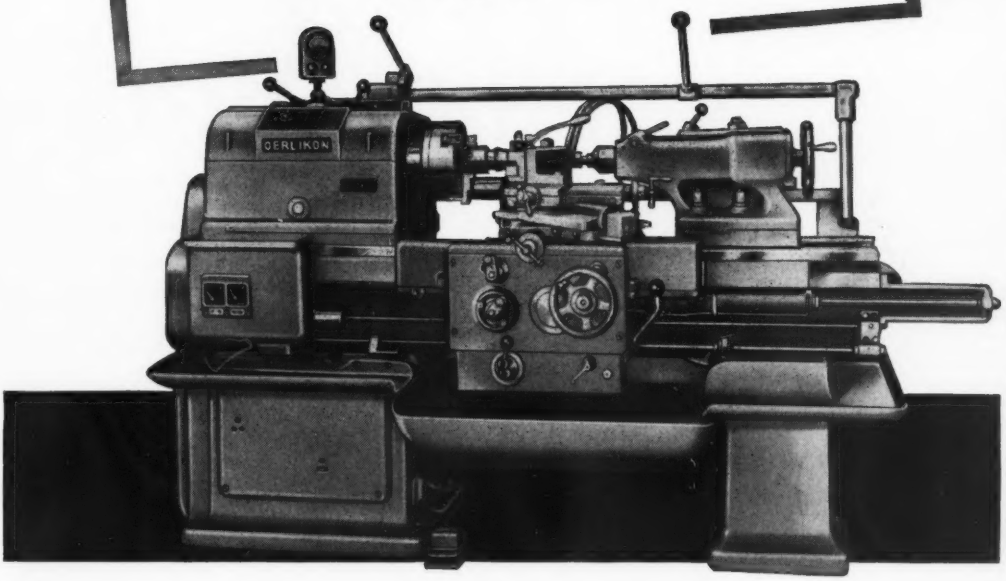

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Swing over bed 17¾". Turning length 23⅝".
Spindle speeds (13) 40 to 2500 r.p.m.

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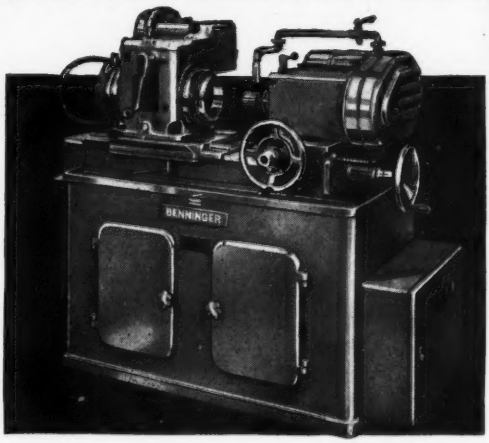

For the more important threading jobs, particularly on difficult materials, you cannot beat the BENNINGER. Equally at home on bulky work or delicate thin-walled components, it is simple, economical and extremely versatile. Almost any thread form can be produced—external or internal, right-hand or left, parallel or tapered, in blind holes or up against flanges, accurately to the last thread—*and* worms. The BENNINGER is more economical too, because a number of machines can be tended by the one 'semi-skilled' operator.

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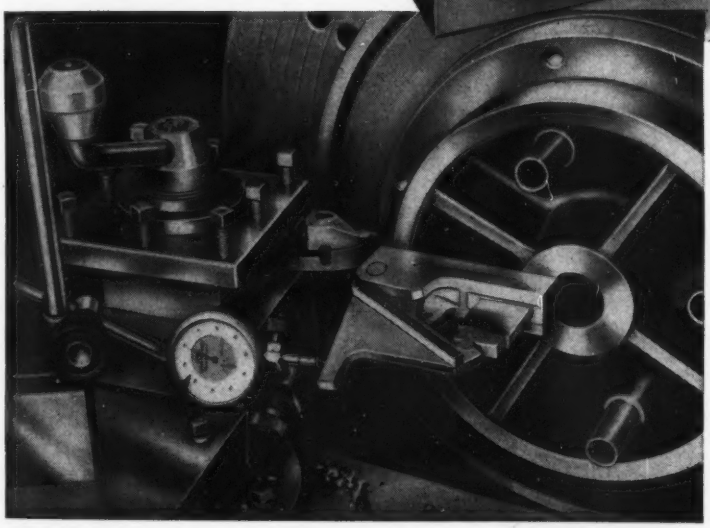
LEAVES BOTH HANDS FREE FOR ACCURATE SETTING!



Essential for the rapid angular setting of machine tables, slides, toolholders or work to extreme limits of accuracy without using makeshifts. Permanent magnets incorporated in the base provide a positive lock-on to the work-piece or machine so leaving both hands free for setting operations.

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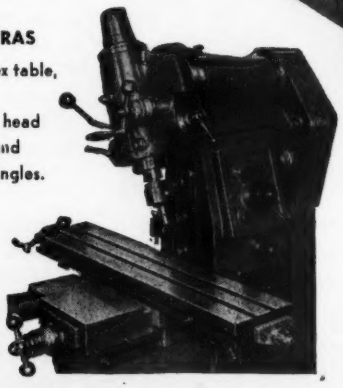

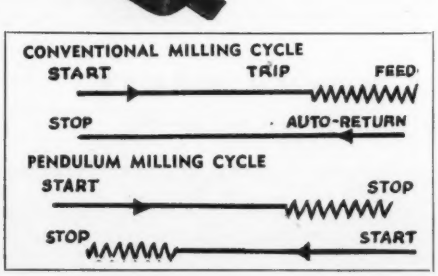

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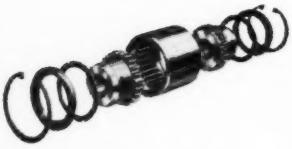

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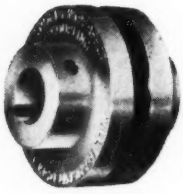

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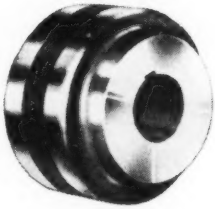

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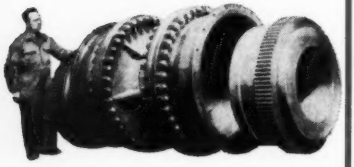

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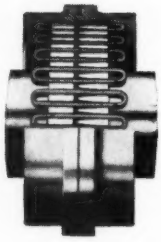

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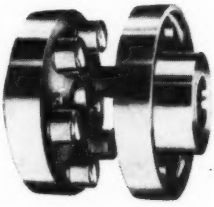

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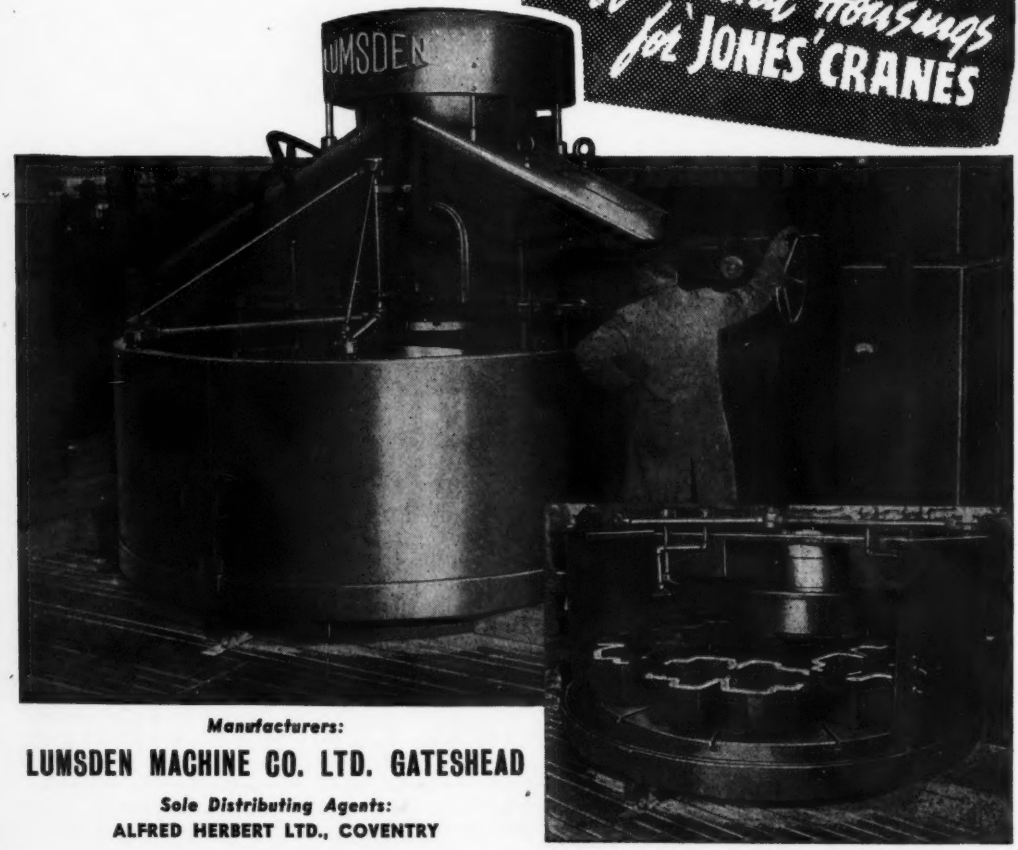

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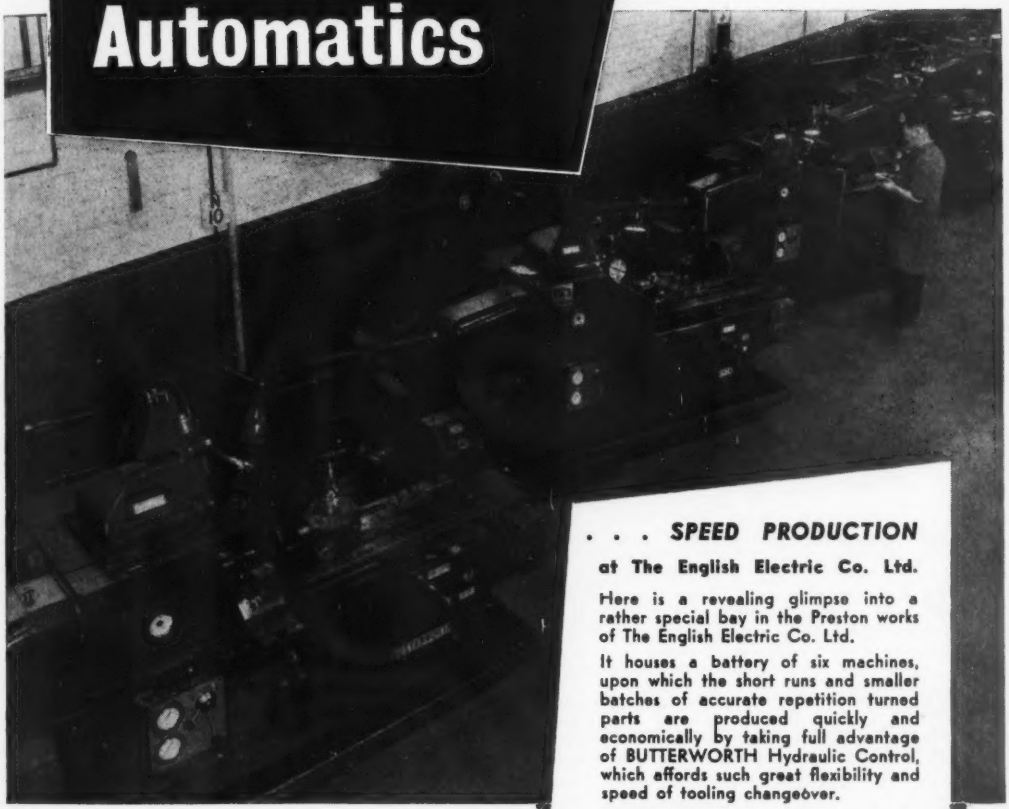

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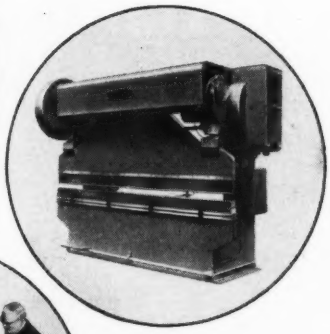

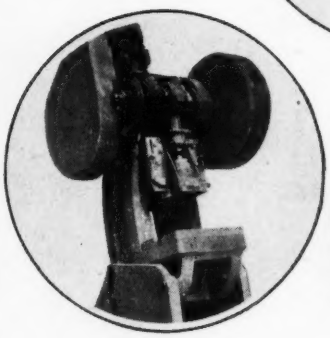

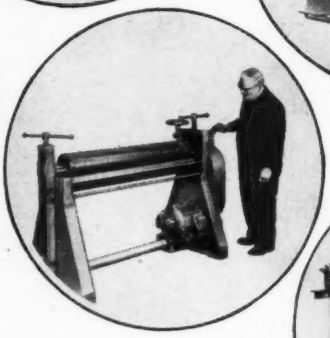

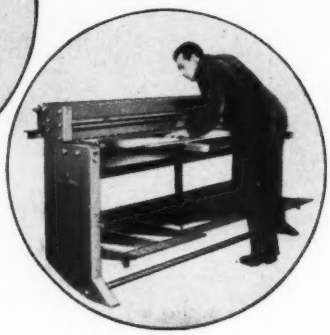

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FJE Besco machines have cut and shaped sheet metal for a variety of useful finished forms . . . from ducting to chick brooders; aircraft to refrigerators; ships to furniture . . . and still they cut and shape sheet metal.

FJE Besco guillotines and shears cut energetically and accurately through ferrous and non-ferrous sheets, press brakes, folders, angle benders and bending rollers form, bend and curve the panels, pans, boxes and mouldings.

FJE Besco swages and wiring machines bead and turn edges for ornamental strength and safety; nibbling machines precisely bite along the edges of intricately shaped templates.

FJE Besco flangers pound the edges of metal blanks and lift the edges high, square and even; presses pierce and stamp endless components in a flood of production.

Yes, indeed, Besco machines are good for sheet metal . . . without them, sheet metal would remain — well just sheet metal !

Excellent terms : monthly account, hire purchase, or the F.J.E. Machine Hire Plan

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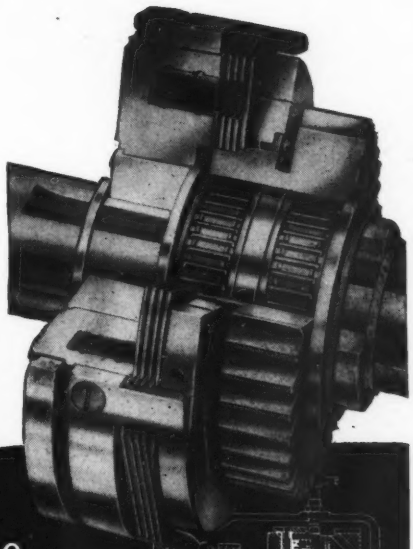

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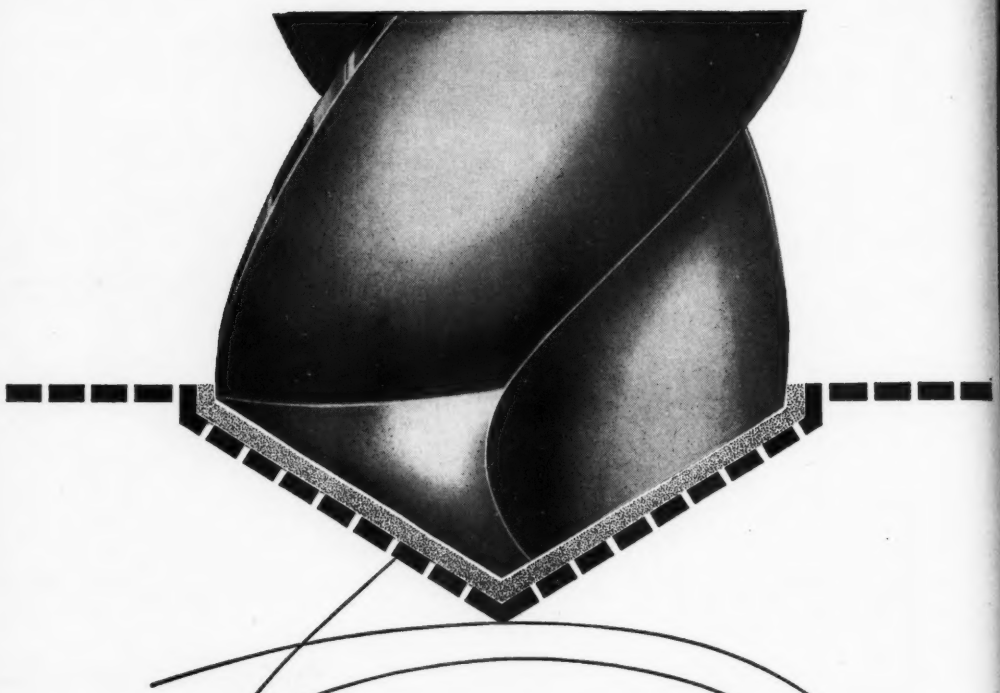

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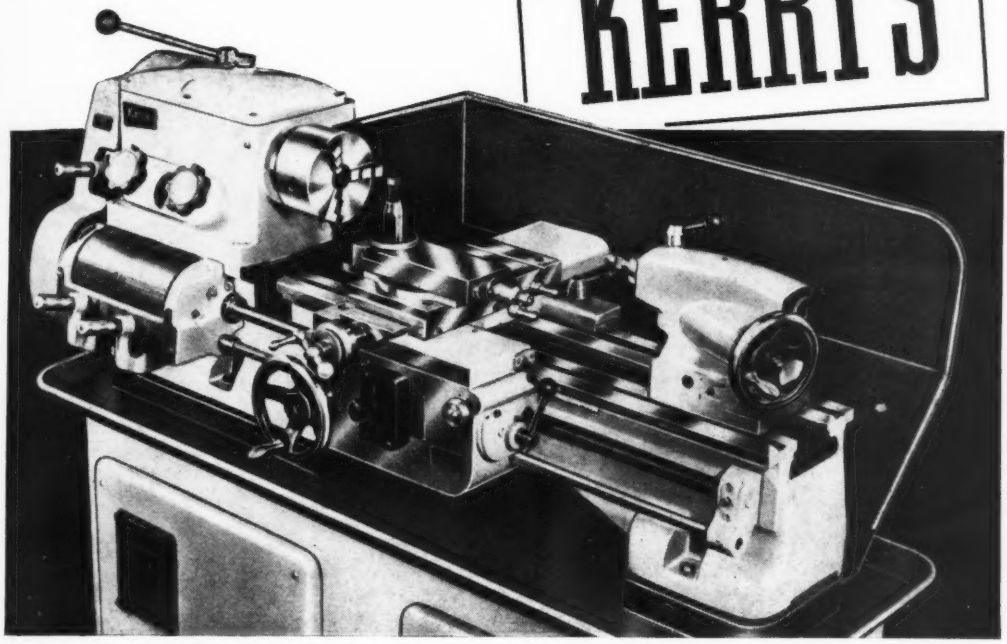

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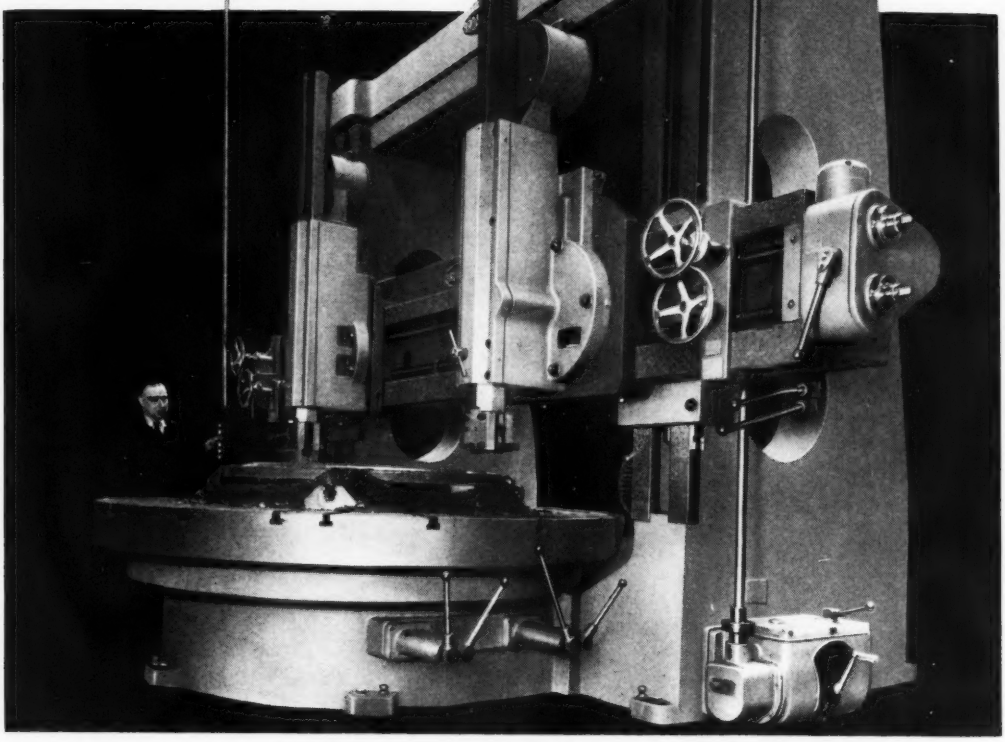

HEAVY DUTY Vertical BORING & TURNING MILLS

with 5, 6, 8 or 10 ft diameter work tables

These incomparable machines are massively constructed for years of hard service. Accuracy and dependability are of the high order that industry has learned to expect of Broadbent Machine Tools. Notable features of these Boring and Turning Mills include twelve changes of speed and six changes of feed, controllable from either side of the machine; spiral bevel and spur reduction gears driving the work table; pendant control of rams and cross slides; and rapid power traverse with independent control of the two heads.

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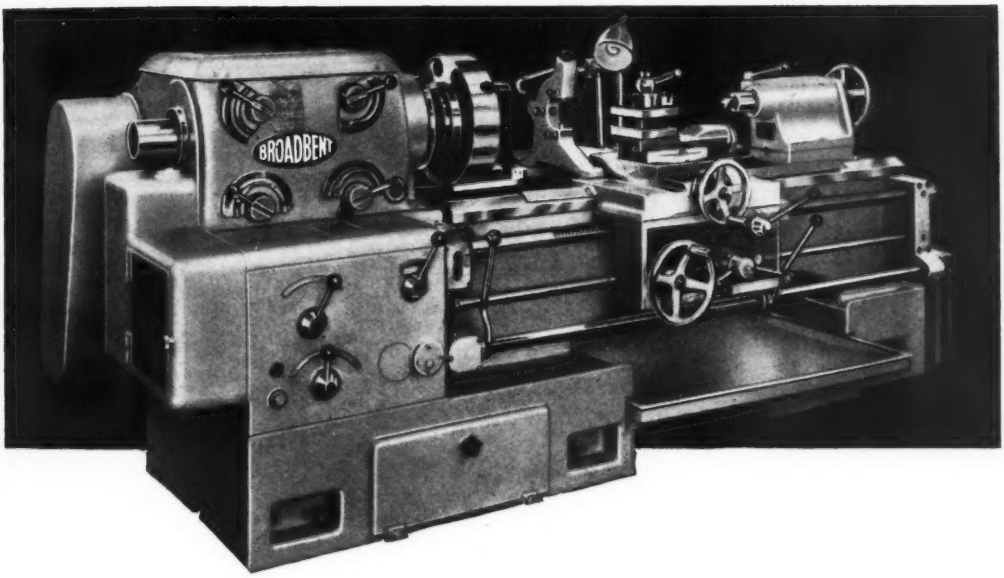
Broadway/HB8

MORE output per man-hour with

BROADBENT

LATHES

Good men plus good tools equal good output. Every Broadbent lathe incorporates almost a century of machine tool building. Manufacturers know that for versatility, accuracy and reliability there is nothing quite as good as a Broadbent Machine Tool.



This 18/22″ Swing Heavy Duty Centre Lathe of modern design is a typical example of the Broadbent range. It has a 15 h.p. drive motor and spindle speeds up to 1,000 r.p.m.

The Broadbent range of Machine Tools includes Surfacing and Screw-cutting Lathes from 17″ to 72″ swing, Surfacing and Boring Lathes, Break Lathes, Crankshaft Lathes and vertical Turning and Boring Mills with 5′, 6′, 8′ or 10′ capacity.

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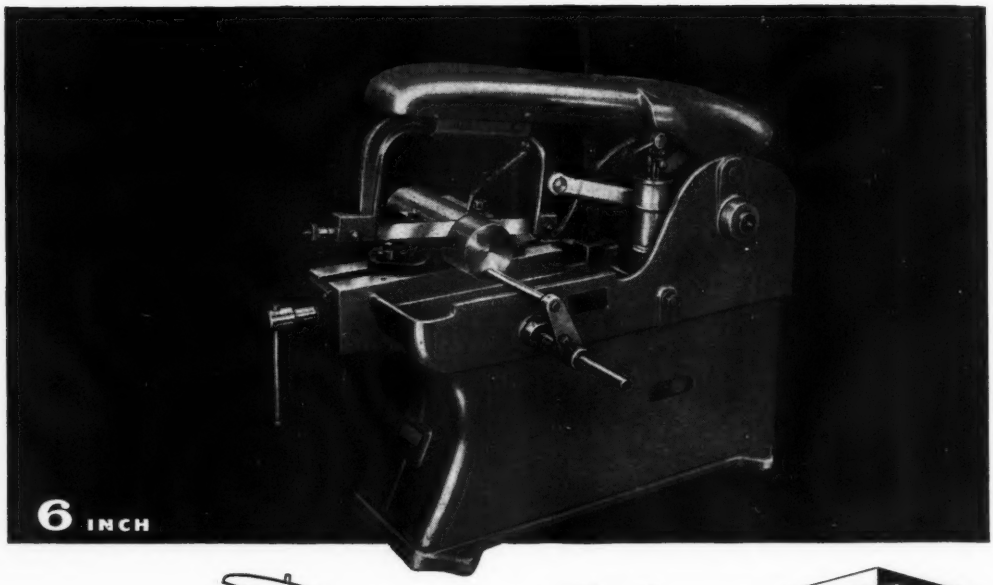

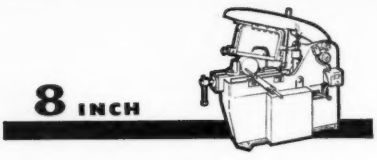

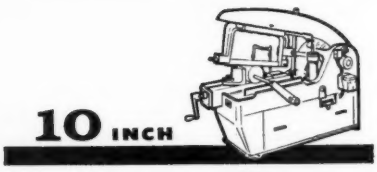

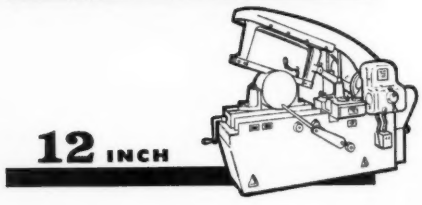

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are the finest
HEAVY DUTY HACKSAWS
in the world

Modern in design, robust and precise in construction, these unrivalled machine saws cut accurately and rapidly, and offer maximum production efficiency. Refinements include totally enclosed drive, hydraulic relief on the return stroke and automatic lifting of the bowslide to loading position on completion of cut.

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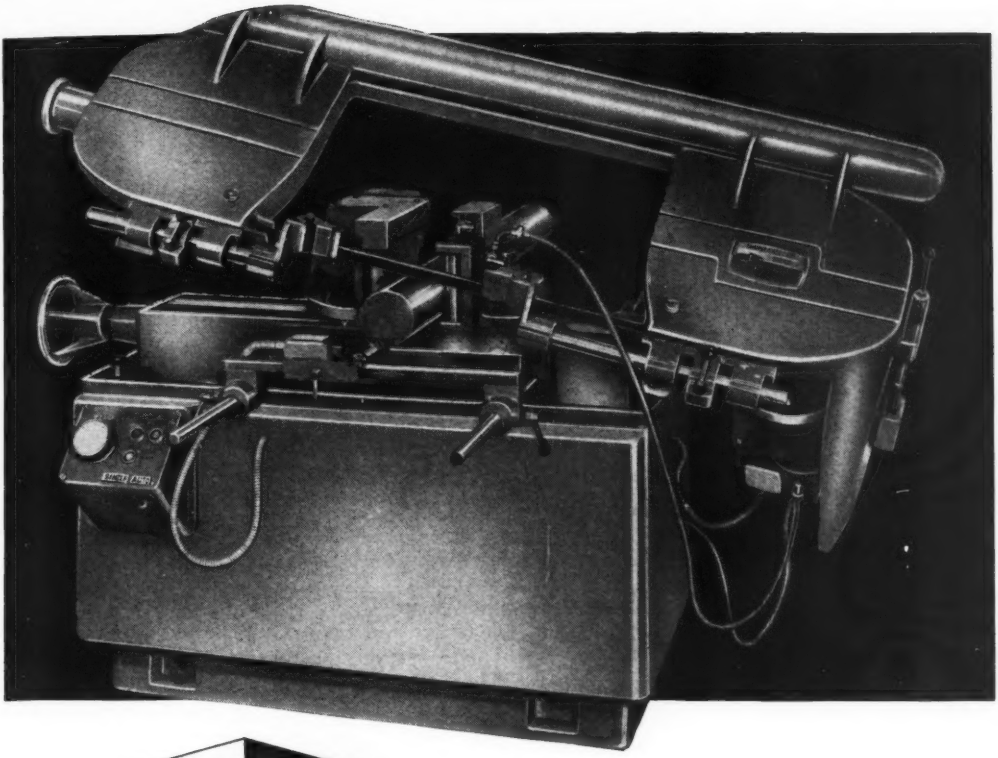

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TYPE 10B AUTOCUT

HEAVY-DUTY BANDSAW

For higher production

Infinitely variable cutting speeds, accurate blade guidance, faster cutting times, power lifting and lowering of sawframe, simplicity of operation and of blade changing mean higher production than with any comparable saw. The completely automatic cutting cycle facilitates repetition work.

the British made Bandsaw that is in the world's top class

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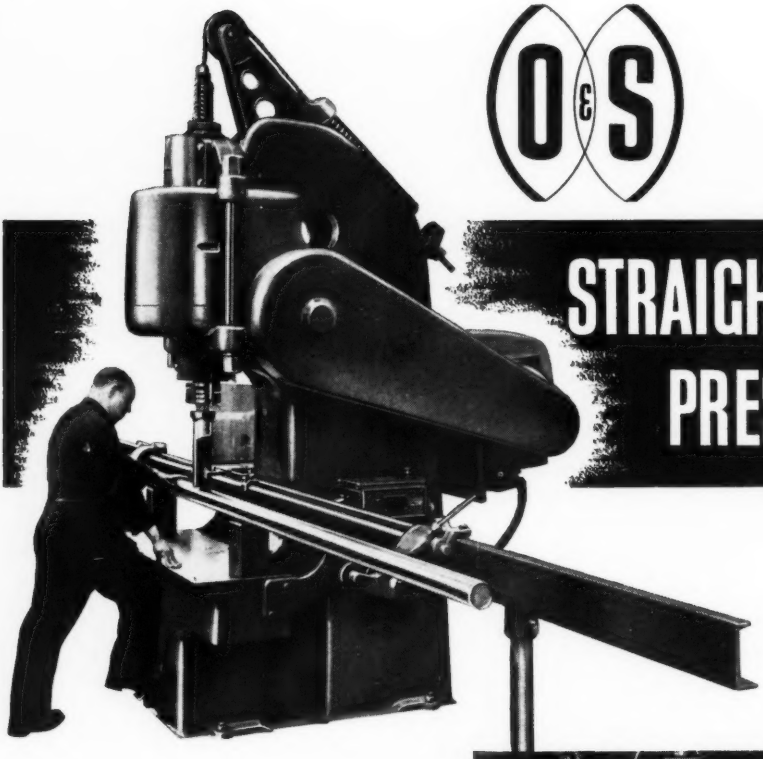

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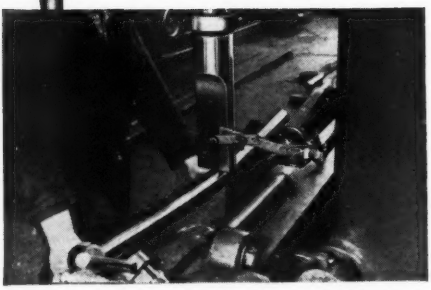
STRAIGHTENING PRESSES

O & S Straightening Presses, made in 5 sizes with capacities ranging from 4 to 60 tons pressure, have for many years been the first choice of engineering firms throughout the world, including most of the leading motor manufacturers. For speed, accuracy and ease of operation, O & S Straightening Presses are in a class of their own.



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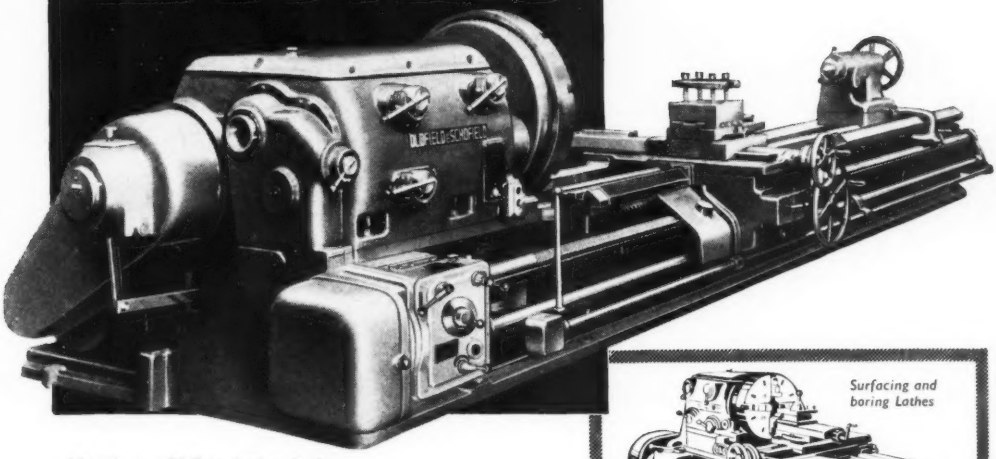
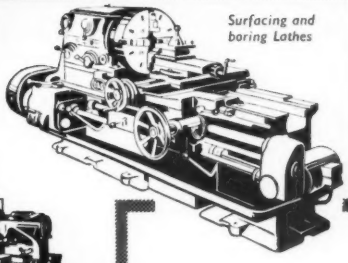
Heavy Duty LATHES

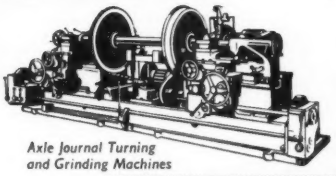
UP TO 96" SWING



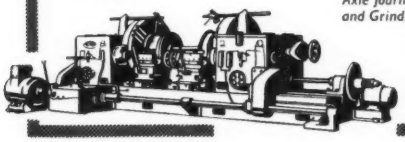
18½" Centre 'D' Type Lathes. Built in sizes up to 48" swing.



Surfacing and boring Lathes



Axle Journal Turning and Grinding Machines



Heavy Duty Double Wheel Lathe

O & S have for many years manufactured a wide variety of heavy lathes which have earned for the company a fine reputation for precision engineering and first class craftsmanship. The range includes Surfacing and Boring Lathes up to 96" swing, Brake Lathes, Axle Lathes, railway carriage and waggon wheel lathes, axle journal turning and burnishing lathes etc., all embodying the latest developments in modern lathe design.

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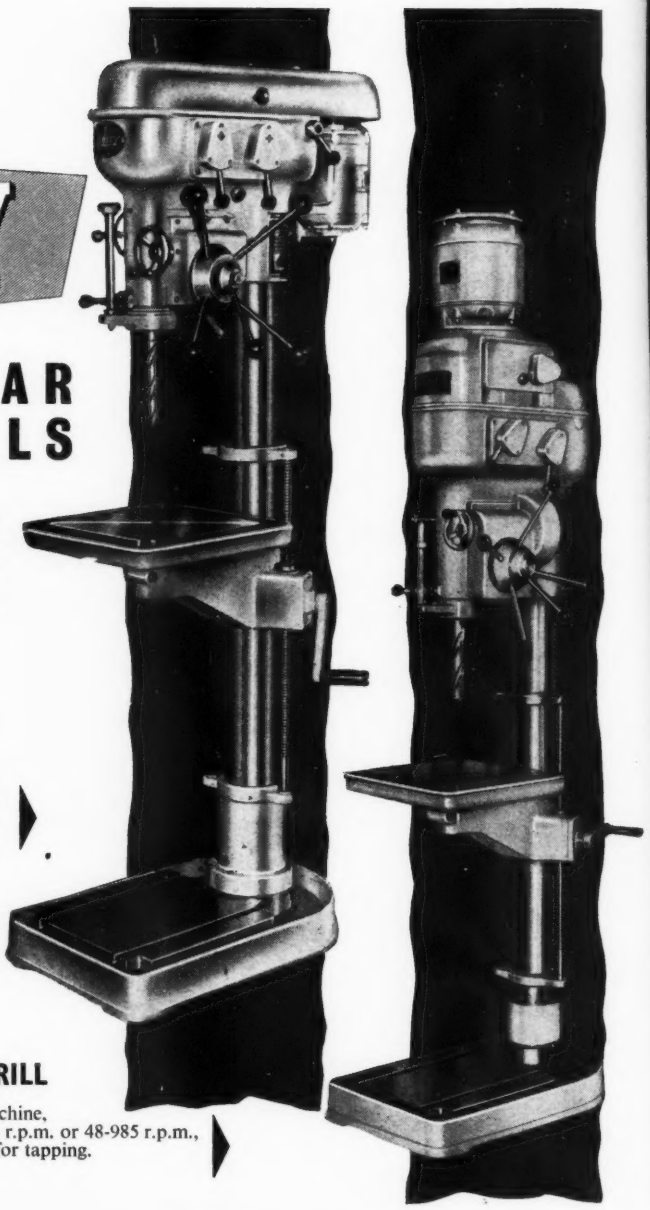

These machines are renowned for their high standard of performance and dependability under the most arduous operating conditions to be found in industry today. Modestly priced, sturdily built and extremely versatile, they will give years of trouble-free service.

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A 1 inch capacity machine with nine speeds ranging from 70-1,500 r.p.m., a lever operated gear change with totally enclosed gear box and power feed, available with either a square or circular table.

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A 1¼ inch capacity, all-geared head machine, giving nine spindle speeds from 70-1,500 r.p.m. or 48-985 r.p.m., 3 rates of power feed reverse to spindle for tapping.

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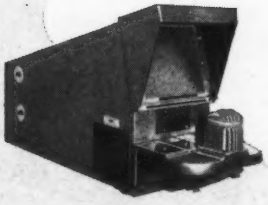

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Similar to Inspection Enlargers, but designed for use in the horizontal position so that the operator can be seated for rapid checking, without fatigue, of mass-produced components.

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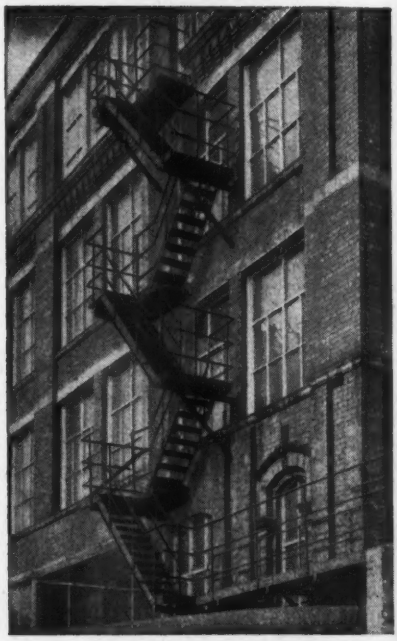

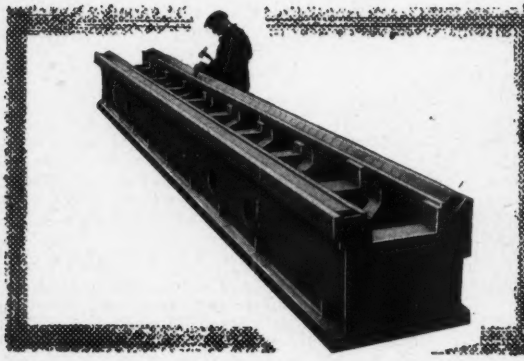

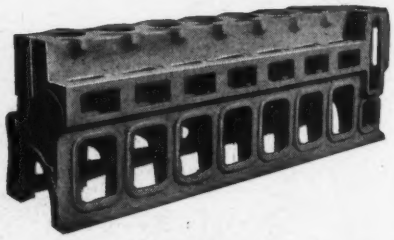

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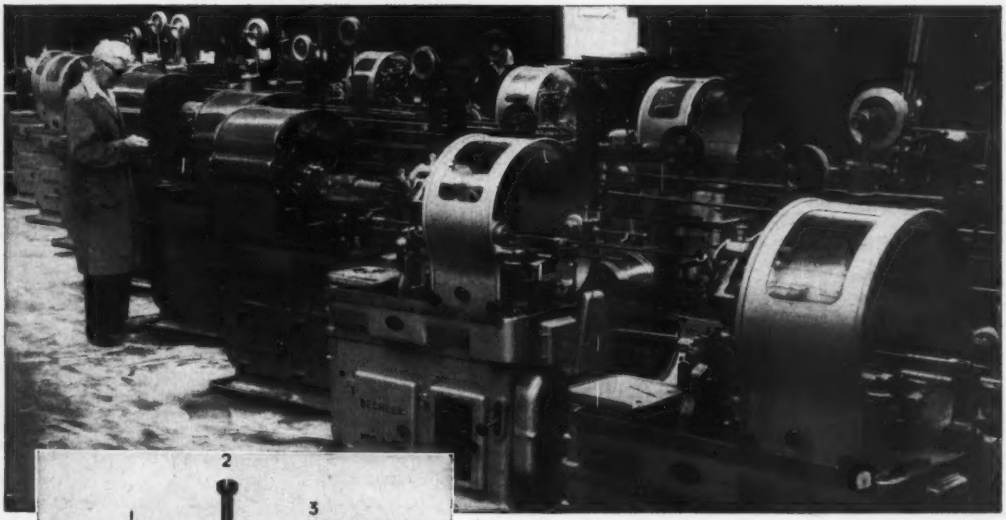

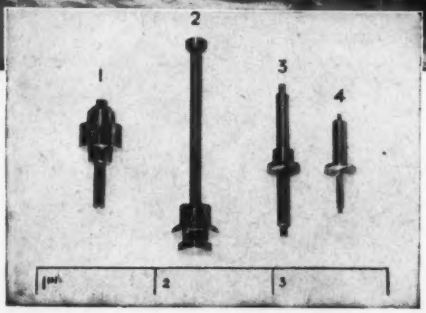

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Production Milling Machine
with automatic cycle

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Let us send you a brochure describing this machine fully.

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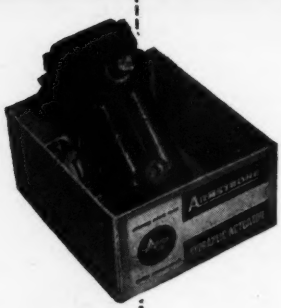

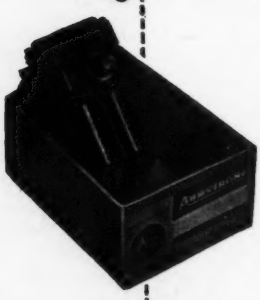

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Armstrong "Off-the-Shelf" Actuators and pump units—manually or power operated—put so many possibilities "within your reach" that early investigation is advised. Ask for leaflet:—APL 51/5.

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For all work that requires the highest accuracy, combined with large scale production, TORNOS automatics are ideally suited. Their unsurpassed performance, precision and workmanship, together with many special technical features, put them in a class by themselves.

Complete range of models to meet all requirements. Ask for details and production times on your own work.

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TORNOS Automatics include the following sizes:

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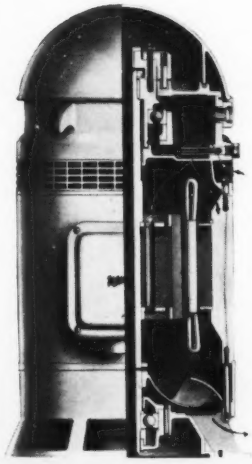
No. 7

Vertical pump motors



Newman vertical solid and hollow shaft pump motors were designed only after a most thorough investigation into the special requirements of both the pump-making industry and pump users. This included on-the-spot surveys in some of the most exacting areas of the world where these motors are used chiefly for essential irrigation purposes.

The result is a range of motors engineered in every detail for the job and able to withstand the rigours of unattended operation in extremes of climate—a range of pump motors accepted by leading pump manufacturers in all parts of the world.

1

2

1 & 2

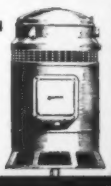
TOTALLY ENCLOSED VERTICAL HOLLOW AND SOLID SHAFT PUMP MOTORS
NEMA bases and to NEMA Standard MG.1. 1½-20 h.p.
List Nos. 601 and 603.

3

3 & 4

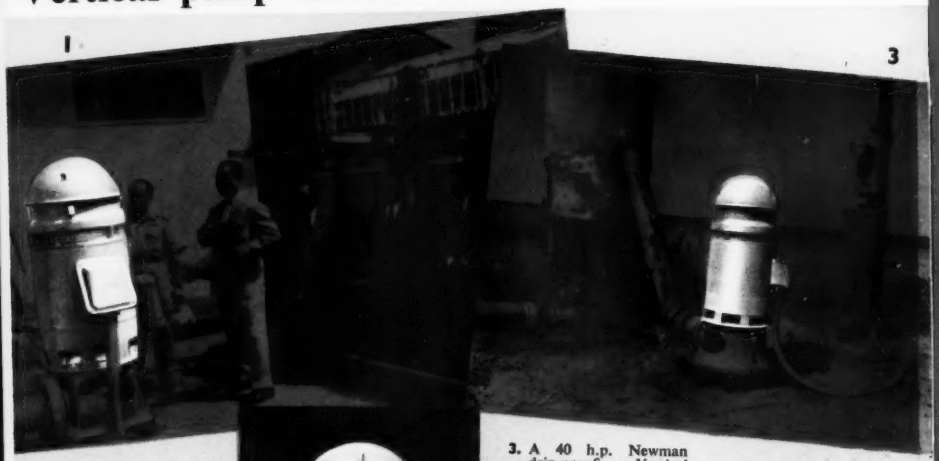
DRIP-PROOF VERTICAL HOLLOW AND SOLID SHAFT PUMP MOTORS
NEMA bases and to NEMA Standard M.G.1. 10-300 h.p.
List Nos. 602 and 604.

4



Newman

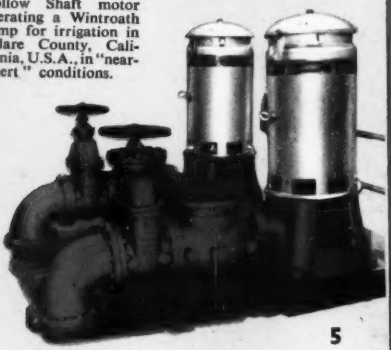
Vertical pump motors at work

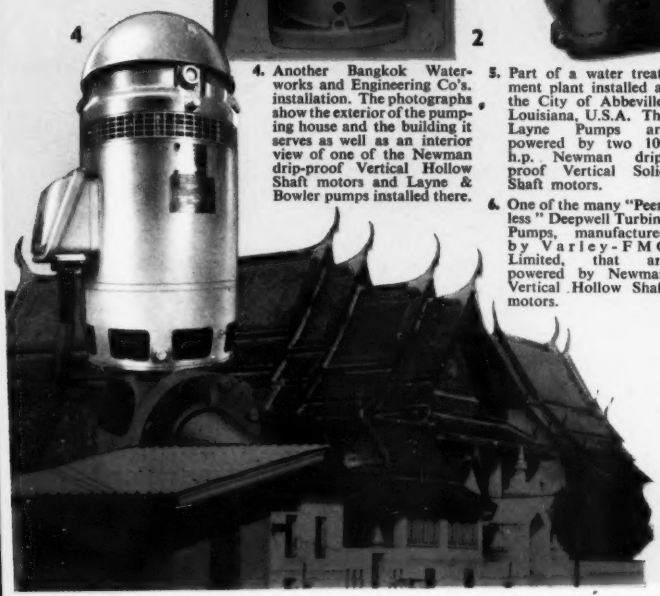


1. The official opening by the Thailand Minister of the Interior of one of the many new pumping installations in Bangkok—in the foreground a Newman drip-proof Vertical Hollow Shaft Pump motor.

2. This Newman, totally enclosed, Vertical Hollow Shaft motor is driving a water pump at the Plicoflex Company, Houston, Texas, U.S.A.

3. A 40 h.p. Newman drip-proof Vertical Hollow Shaft motor operating a Wintroath pump for irrigation in Tulare County, California, U.S.A., in "near-desert" conditions.

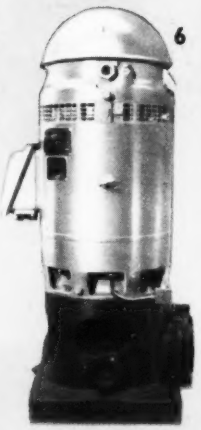




4. Another Bangkok Waterworks and Engineering Co's. installation. The photographs show the exterior of the pumping house and the building it serves as well as an interior view of one of the Newman drip-proof Vertical Hollow Shaft motors and Layne & Bowler pumps installed there.

5. Part of a water treatment plant installed at the City of Abbeville, Louisiana, U.S.A. The Layne Pumps are powered by two 100 h.p. Newman drip-proof Vertical Solid Shaft motors.

6. One of the many "Peerless" Deepwell Turbine Pumps, manufactured by Varley-FMC Limited, that are powered by Newman Vertical Hollow Shaft motors.



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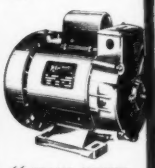
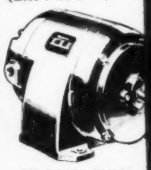
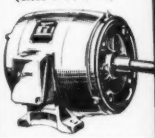


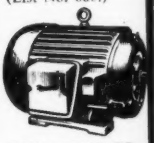
66-FRAME MOTORS
British or Americ Standards. NEV Dimensions ½-3 h (List No. 5 4)



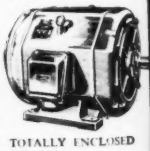
DRIP-PROOF SINGLE-PHASE MOTORS
British or Americ Standards. New NEM Dimensions. ½-5 h.p (List No. 105.)



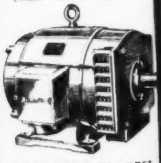
CLOSE COUPLED PUMP MOTORS
British or Americ Standards. New NEM Dimensions. ½-150 h (List No. 605.)



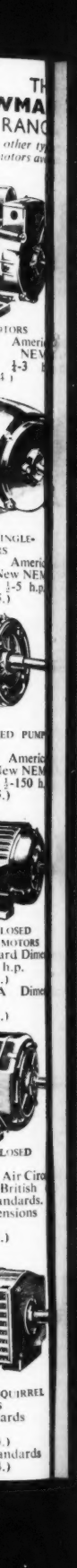
TOTALLY ENCLOSED THREE-PHASE MOTORS
British Standard Dime sions. ½-60 h.p. (List No. 301.)
New NEMA Dime sions.
(List No. 302.)



TOTALLY ENCLOSED MOTORS
With Double Air Circ Cooling. British American Standards. NEMA Dimensions 25-250 h.p. (List No. 305.)



DRIP-PROOF SQUIRREL CAGE MOTORS
British Standards 75-600 h.p. (List No. 103.)
American Standards (List No. 104.)



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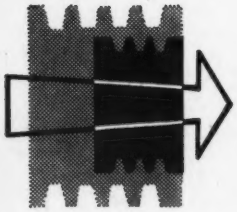

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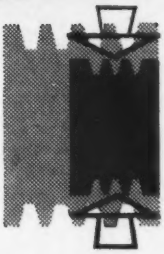

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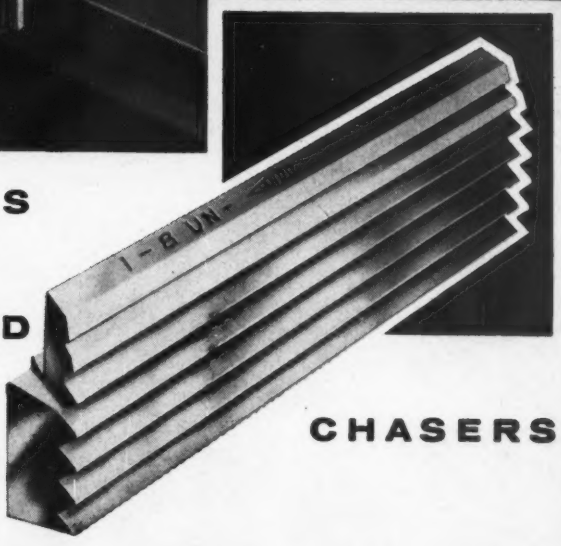

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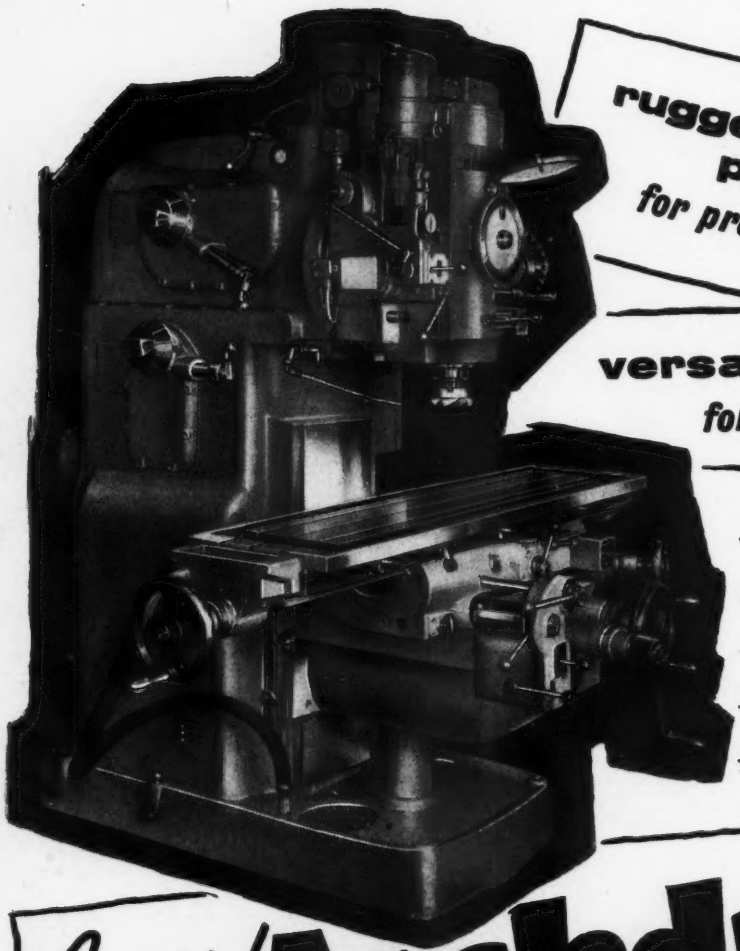

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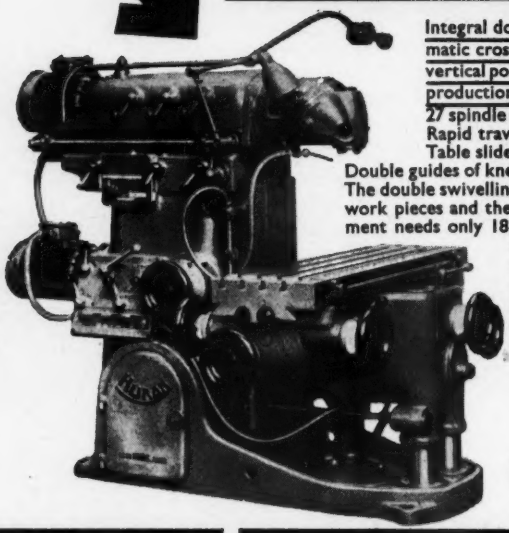

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Type	Table	Automatic Feeds Long	Cross	Vert.
KU4	56½in. × 15½in.	43½in.	27½in.	19½in.
KU5	64½in. × 15½in.	51½in.	27½in.	19½in.
KU6	70½in. × 16½in.	59in.	27½in.	19½in.
KU55	64½in. × 26in.	51½in.	39½in.	18½in.
L83	157in. × 59in.	118in.	39½in.	59in.

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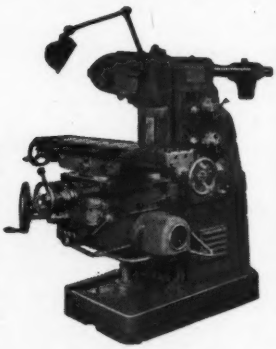

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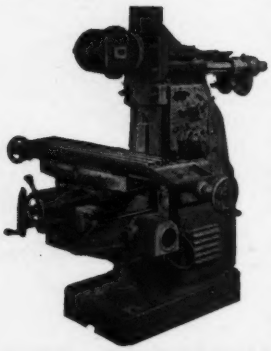

MODELS 53 & 61. 16 universal head spindle speeds 21-1600 r.p.m.; 8 horizontal spindle speeds 21-1180 r.p.m.; 8 automatic feeds ½-18¾in

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MODEL 54. Automatic cross feed of universal head 20in.; 18 universal head spindle speeds 12-1500 r.p.m.; 36 horizontal spindle speeds 6-1500 r.p.m.; 18 automatic feeds $\frac{1}{32}$-23¾in.

Type	Table	Automatic Feeds Long.	Cross	Vert.
53	43½in. × 9in.	27½in.	9in.	15½in.
61	47½in. × 10in.	30½in.	9½in.	15½in.
59	51½in. × 11in.	34½in.	11½in.	21½in.
54	67in. × 14½in.	43½in.	14½in.	20½in.

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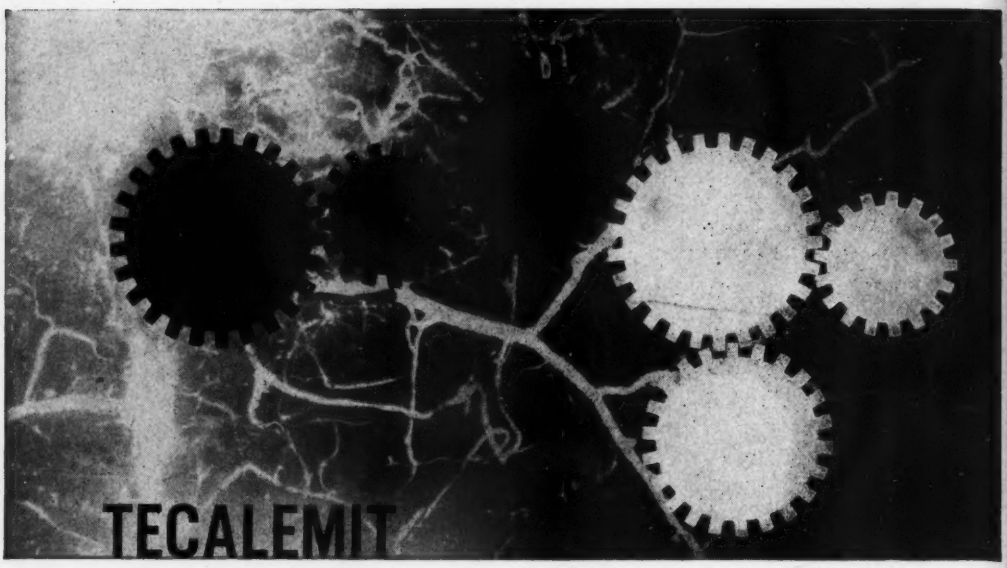

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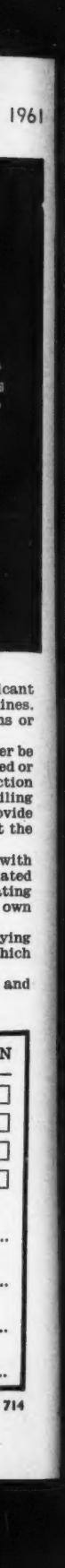

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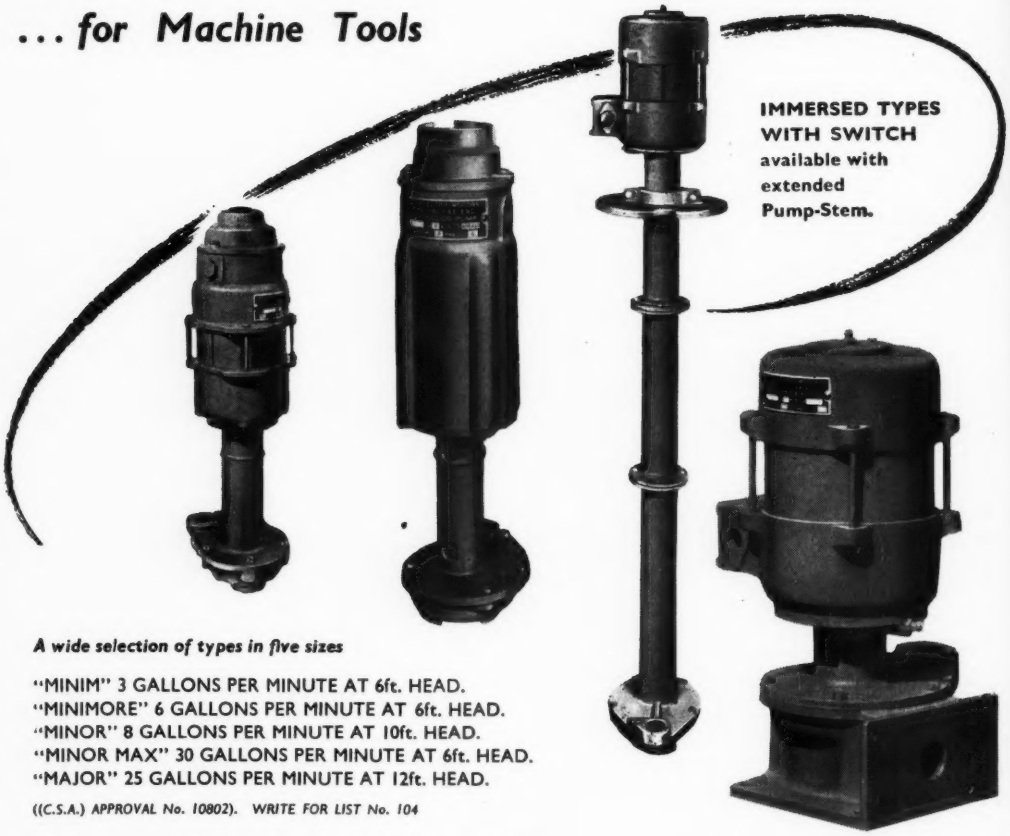

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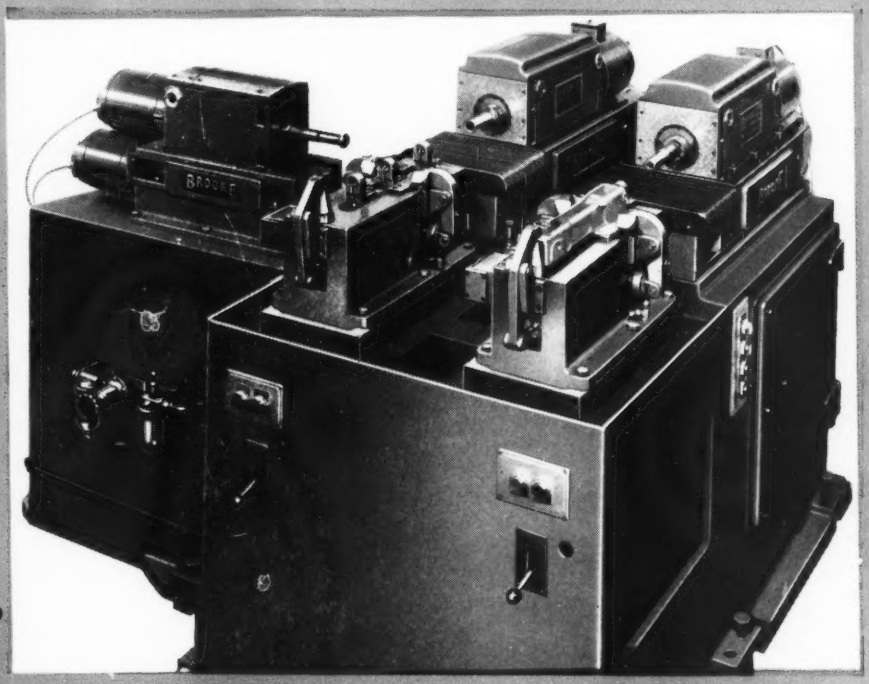
UNIT MACHINES AND UNIT HEADS

Illustrated is a Three Unit Drilling and Line Reaming Machine for processing gear box top cover components. The operations are the drilling of the longitudinal shaft hole through bushes utilising a jump gap cycle, the reaming of the same hole and the tapping of one hole in the side of the component. The main structure of the machine is a fabricated plate steel base to which one UHO and two UHI BROOKE UNIT HEADS and two Fixtures are mounted. The Fixtures are easily loaded and clamping is effected by pneumatic means, all controls being readily available for ease of operation. The machine base houses the electrical control equipment, the coolant sump and the pump of suitable capacity.



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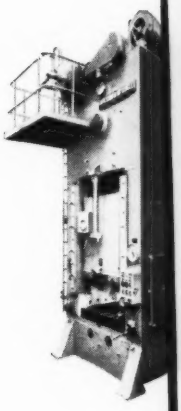

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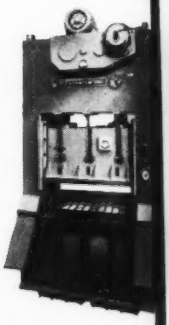

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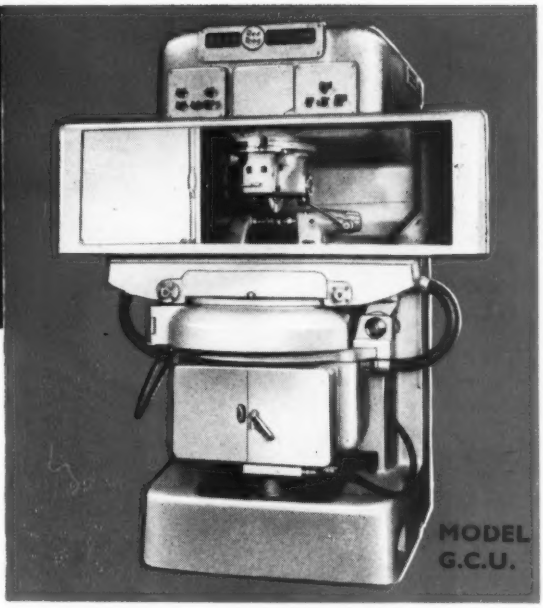
UNIVERSAL DIAGONAL GEAR SHAVING



All of the significant improvements and refinements in gear shaving practice for the past 30 years are incorporated in the Red Ring Universal Diagonal Gear Shaving Machine, Model GCU, to make it the most versatile and effective unit of its kind ever built.

In accordance with Red Ring practice, the cutter head which is a relatively small unit is located above the work. Head and tailstocks together with the tables comprise a much heavier unit located below the work and always under compression whether at rest or under load. After being set, the cutter head is clamped while the tables have running clearance.

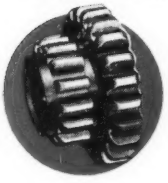
This arrangement also provides two additional advantages. If the work gear is accidentally dropped when being loaded, it cannot damage the cutter. With the cutter above the work chips readily fall away from it.

Gears may be shaved by either the conventional or diagonal method on the Red Ring Model G.C.U.

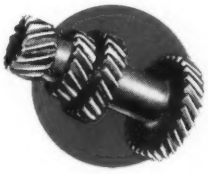
Gear teeth may be shaved straight, crowned, tapered or to conical form. When crowned, the position and amount of crown may be located along the tooth as required.

Wide or narrow face gears, open or close shoulder gears, plunge hobbed gears or gears with long shafts can be shaved on the Red Ring Model G.C.U.

Loading and unloading may be manual, semi-automatic or fully automatic.



The smaller unit only of this steel cluster gear was shaved in 15 seconds, removing .006in. of stock over pins-crossed axes angle 3°. Unit is 2 $\frac{5}{16}$in. in diameter. It has $\frac{15}{16}$in. face, 14 teeth, a 6/8 D.P. and is a close shoulder job.



The large gear on the right of this transmission cluster was crown-shaved in 16 seconds, removing .010in. of stock over pins. It is a 4in. diameter steel gear having a $\frac{11}{16}$in. face, 29 teeth and 9.25 D.P.

This aluminium timing gear was shaved in 25 seconds, removing .010in. of stock over pins. It is 6$\frac{1}{2}$in. in diameter, has a 1in. face, 56 teeth and 10 D.P.

This steel automatic transmission planetary pinion was shaved in 27 seconds, removing .007in. of stock overpins. It has 21 teeth 1.500in. P.D., 14.75 D.P., and a face width of 2$\frac{1}{8}$ in.

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An Associate Company of National Broach & Machine Co., Detroit, U.S.A.
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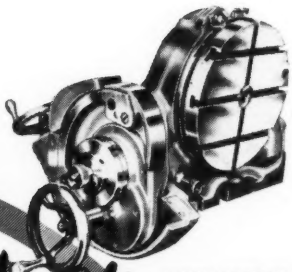

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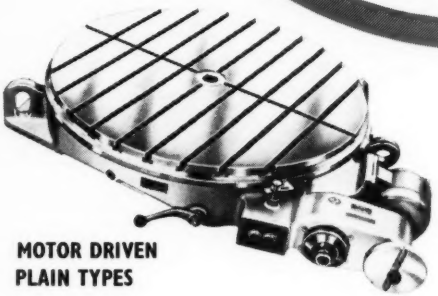

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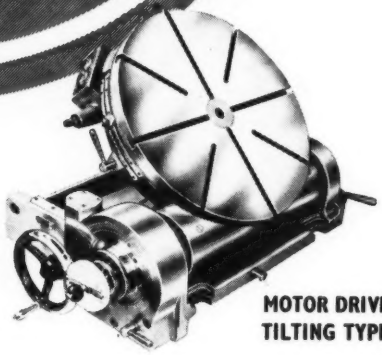

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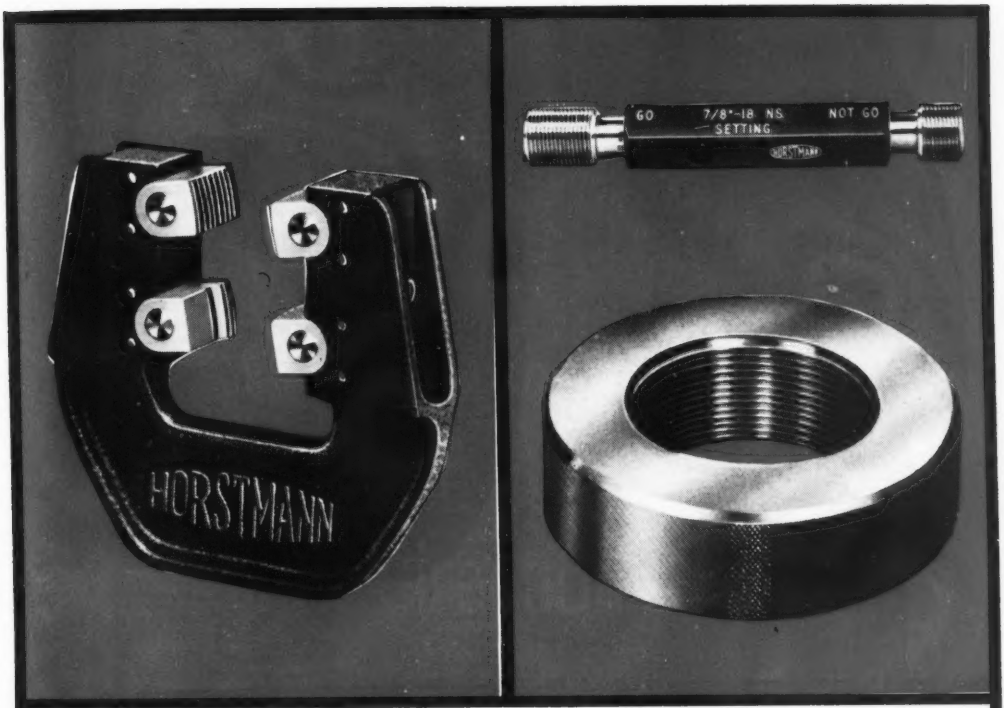

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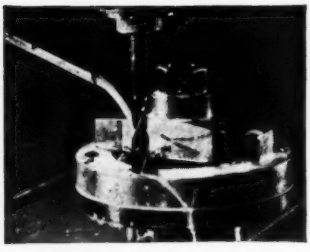

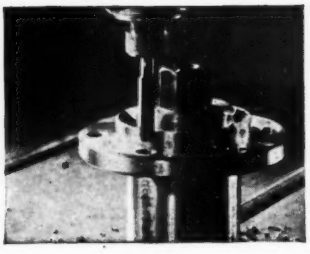

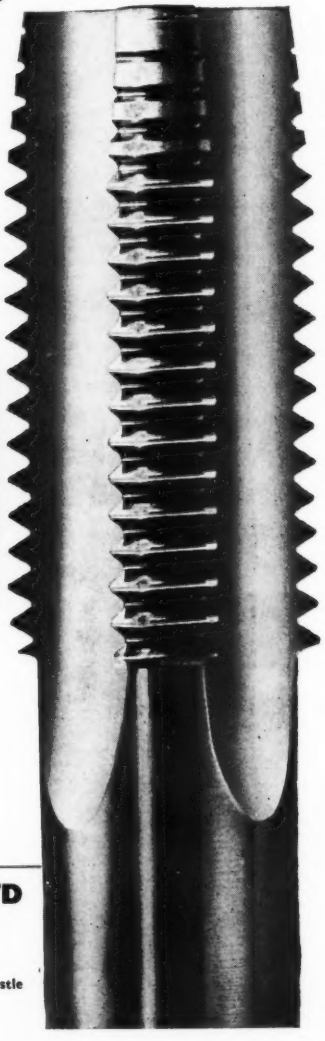

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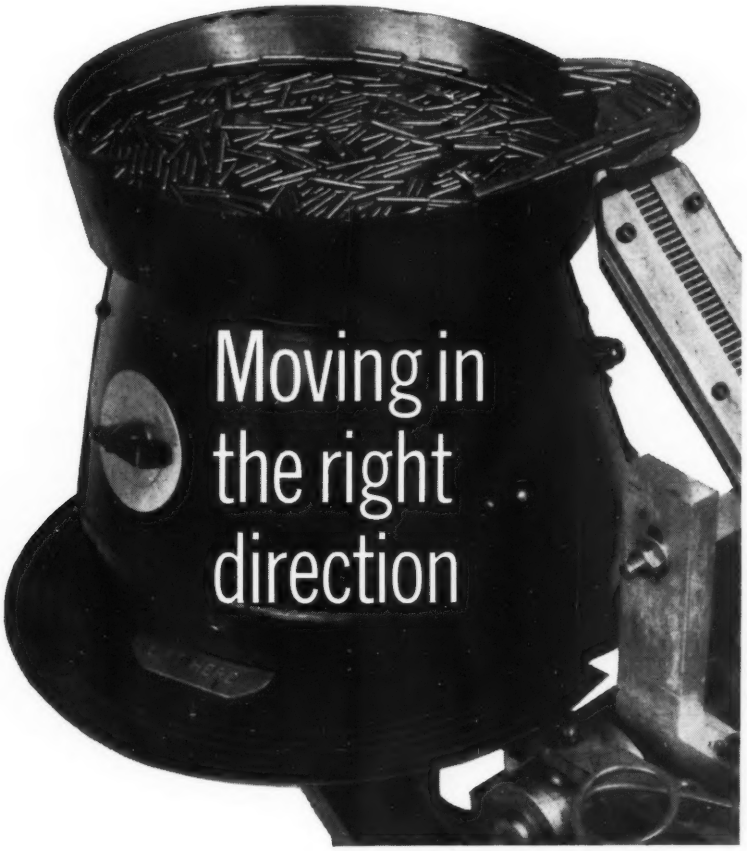

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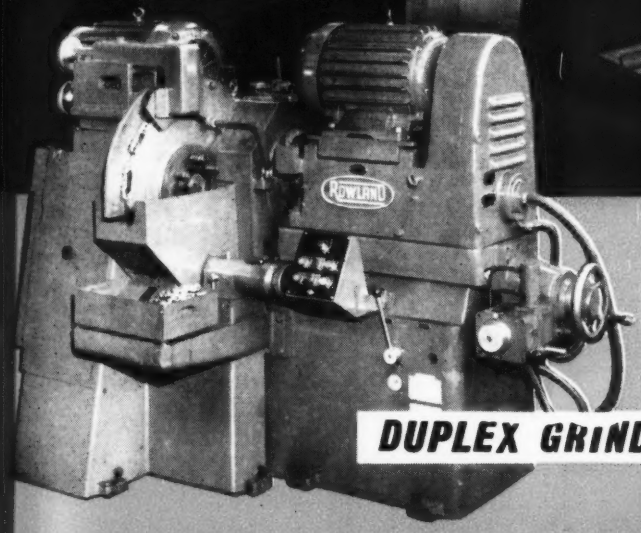

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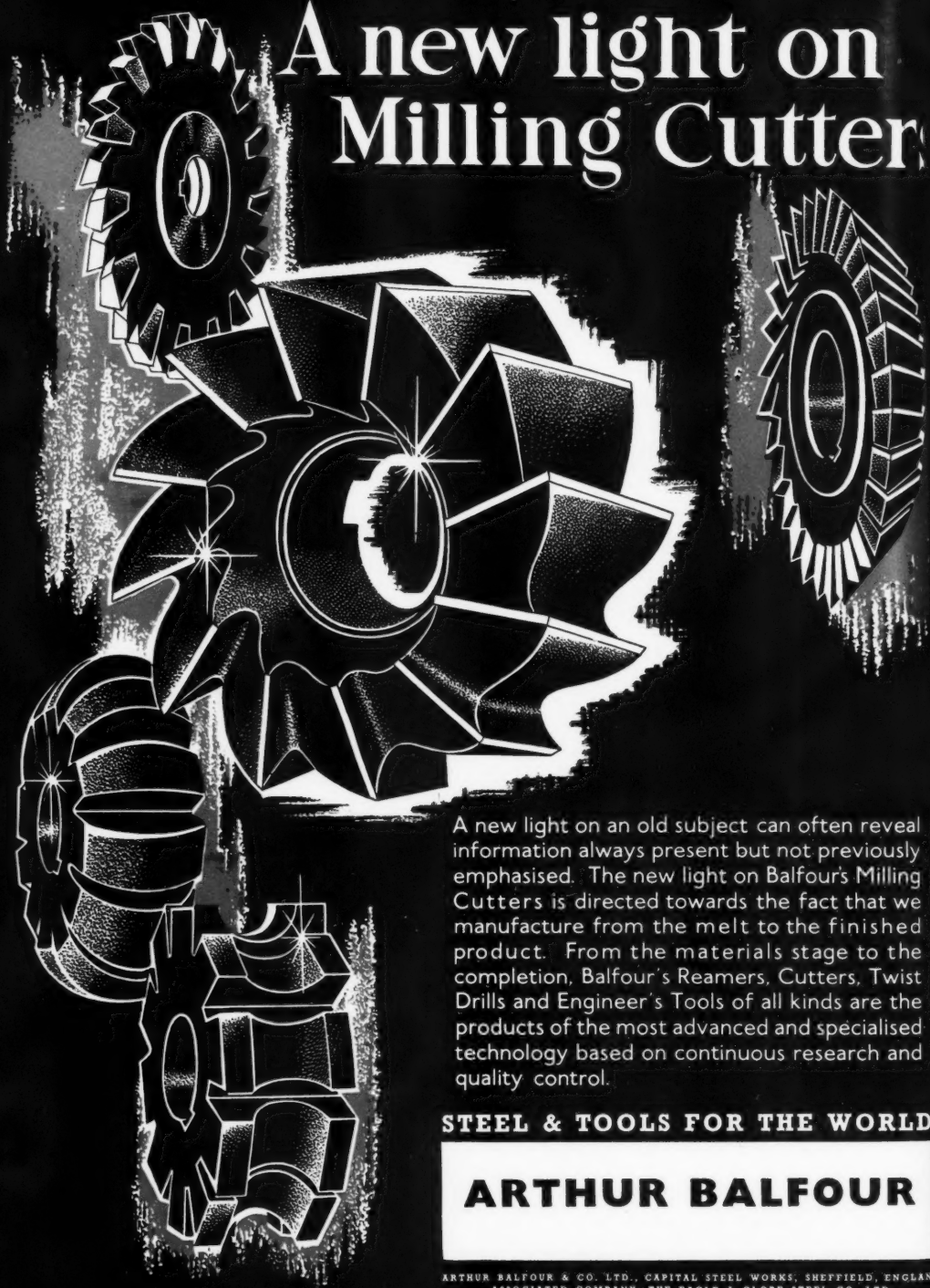

A new light on an old subject can often reveal information always present but not previously emphasised. The new light on Balfour's Milling Cutters is directed towards the fact that we manufacture from the melt to the finished product. From the materials stage to the completion, Balfour's Reamers, Cutters, Twist Drills and Engineer's Tools of all kinds are the products of the most advanced and specialised technology based on continuous research and quality control.

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TECHNICAL NEWSHEET

ITEM	Ronson Gas Lighter Body
OPERATION	Drill, counterbore, spotface, tap-all holes

The Rotary Transfer Machine illustrated is interesting because it utilises readily available standard items from our range. Ronson Products Ltd., the largest manufacturers of cigarette lighters in the U.K. designed the machine in collaboration with our engineers, to drill, counterbore, spotface and tap all the holes in a butane gas lighter. A 10 station, pneumatically-operated rotary indexing Table, specially designed for this duty, is fed with unmachined bodies held in separate holding fixtures which are carried to the loading station on a gravity feed roller conveyor. The positioning, final location and clamping of the fixture on the table is fully automatic. The complete machining cycle (detailed at right) is fully automatic and on the completion of each cycle a machined part is ejected in its carrier fixture down the conveyor for unloading. The operation of all spindles is positively interlocked with table movement and it is impossible for any spindle to advance unless the table is fully locked at the correct machining position.

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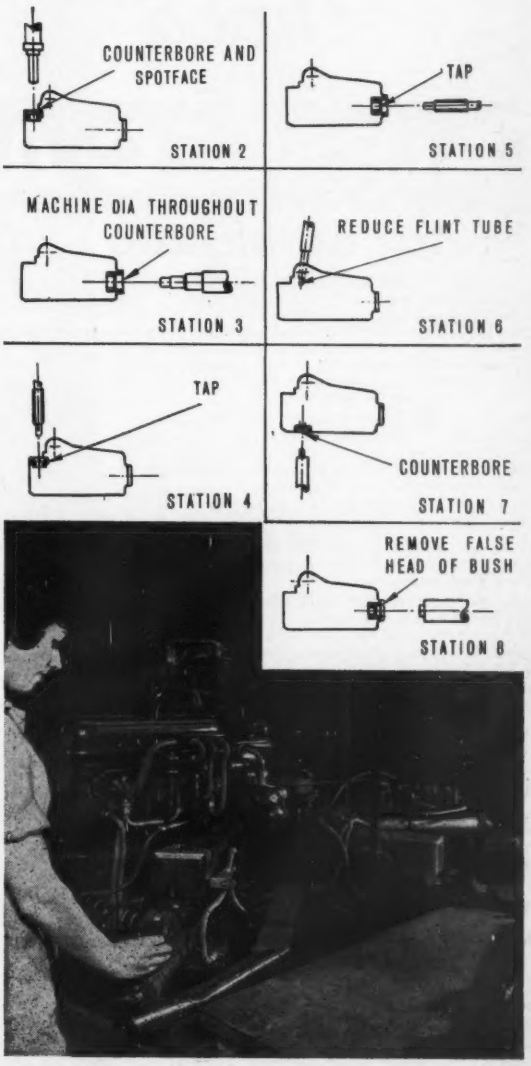

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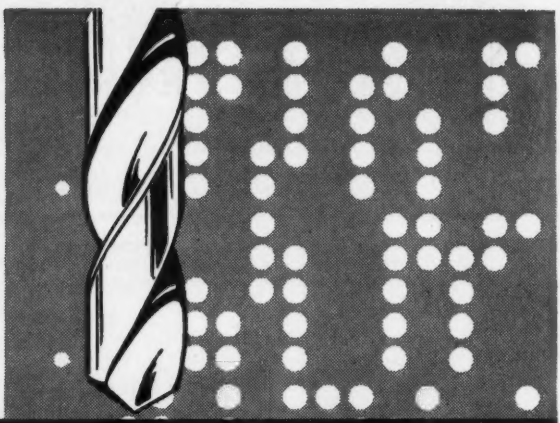

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for automatic drilling

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Facilities are provided for selecting one of up to ten tools and for controlling a large number of other variables such as tool rates, feed depths and spindle speeds.

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No electronic valves used.

EASY MAINTENANCE
Autoset has been designed for trouble-free service and easy maintenance.

CUTS OUT ERRORS
Autoset is highly accurate—automatic compensation is provided for table backlash and cumulative lead screw errors.

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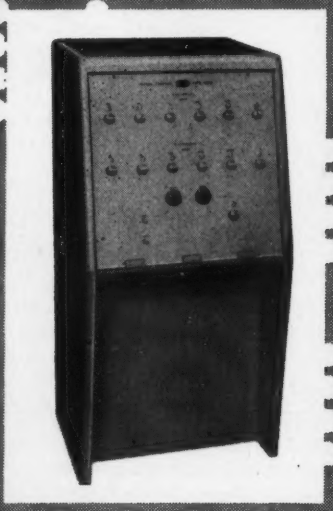
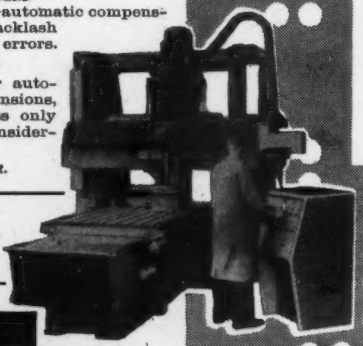
A complete equipment for automatic control in two dimensions, including tape punch costs only £1,500. Manual control considerably less.

Descriptive leaflet No. 186 on request.





Autoset fitted to Wadkin TCD. Full details available from Wadkin Ltd., Green Lane Works, Leicester.

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Low cost tape control

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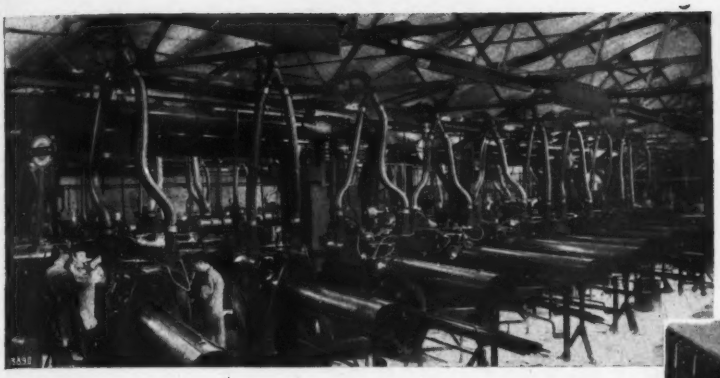
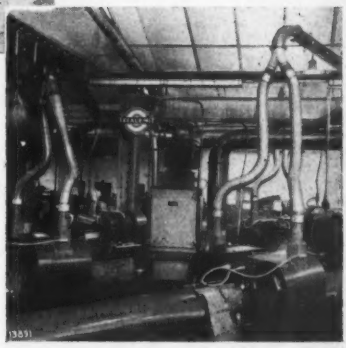


The lower illustration shows one of the 20 PRECIPITRON plants, each serving up to six machines.



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from well over 100 automatics with

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The installation at Tecalemit was made without interfering with production in any way.

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- **Over 90% of oil mist and fume removed**
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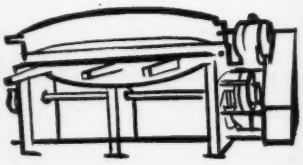

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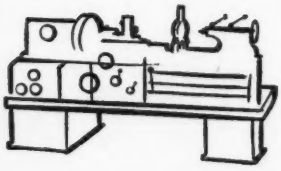

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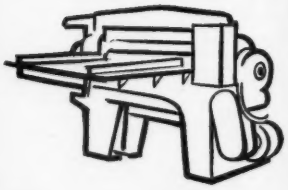

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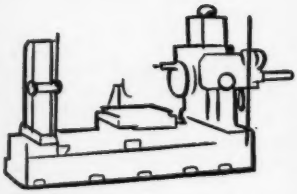

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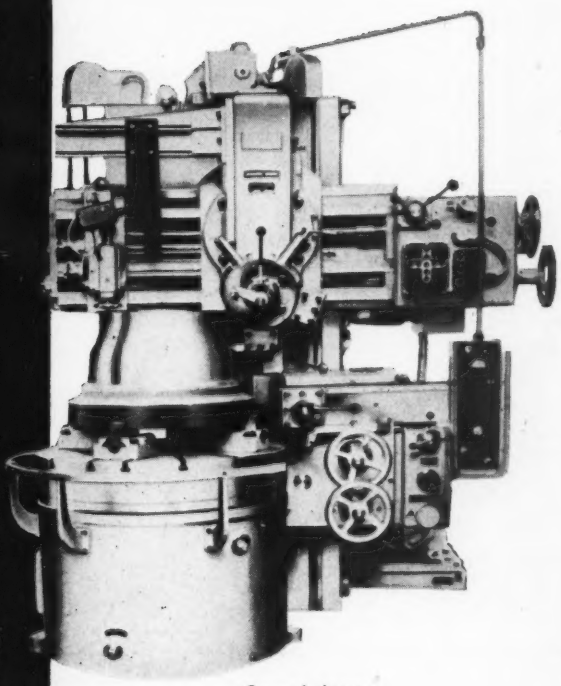

SPECIFICATION:

Work table dia.	1100 mm
Max. height of workpiece	960 mm
16 table speeds ranging from 4.5 to 140 r.p.m.	
Max. weight of workpiece	3000 kg
Main electric motor	20 kW

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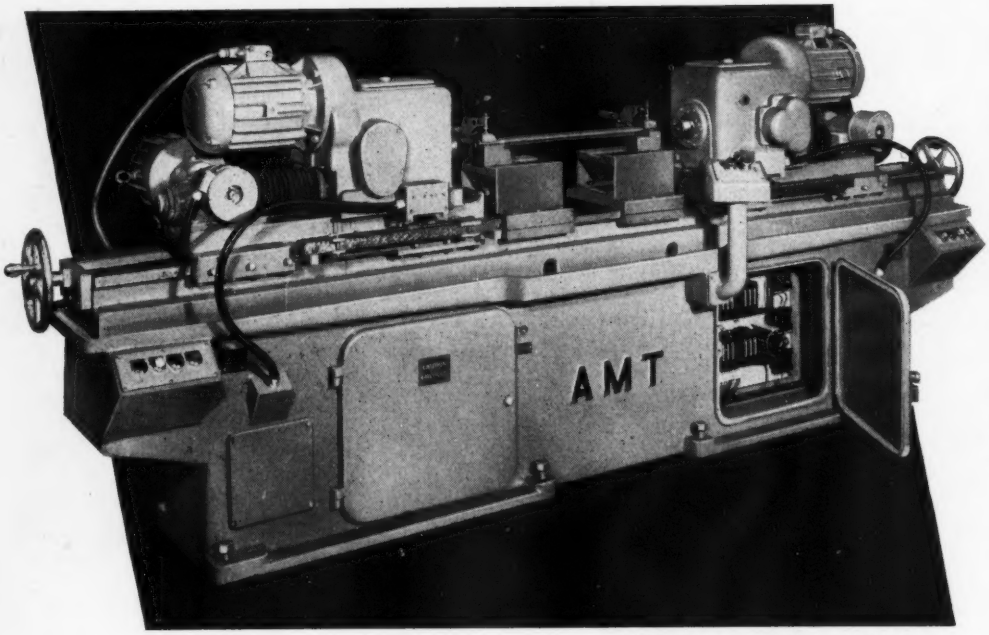

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Double Ended Machine incorporating two A.M.T. DI Units of 2 H.P. Capacity, each unit separately adjustable on the base to accommodate lengths of components up to 48 inches in length. Each unit can be individually or collectively operated on the following cycles:

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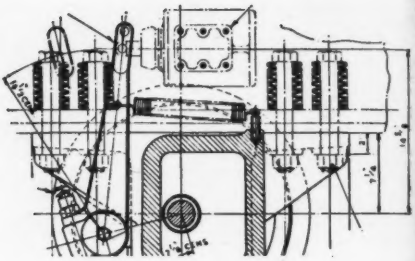
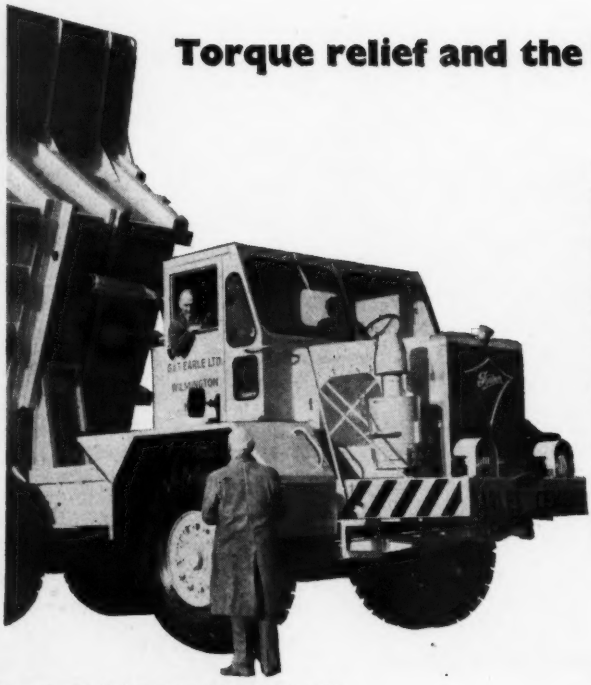


Torque relief and the Belleville Washer



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Messrs. Fodens Ltd., fit Belleville washers in packs of 7 pairs on their F.R.6/45 Heavy Duty Dumper. This proved to be the most effective method of relieving twisting of the rear axle case produced by braking and transmission torques.

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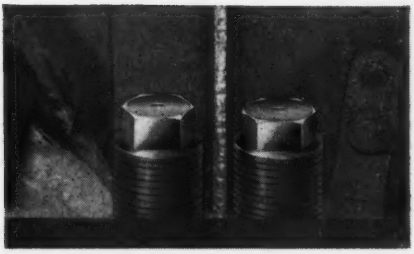

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PART NAME: Jet Engine Blade.
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MACHINE SIZE: Type "C" 12 x 16 x 44 Truform Grinder.
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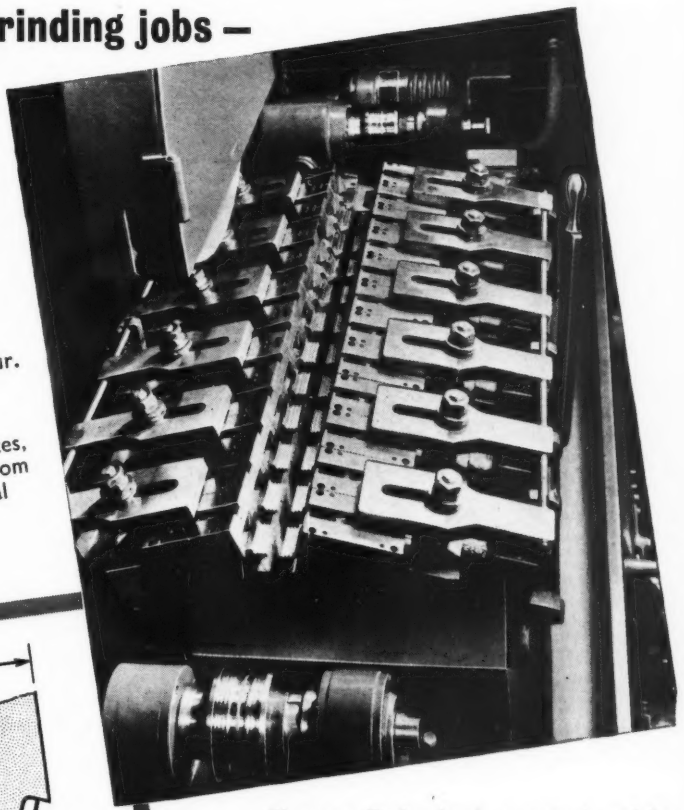
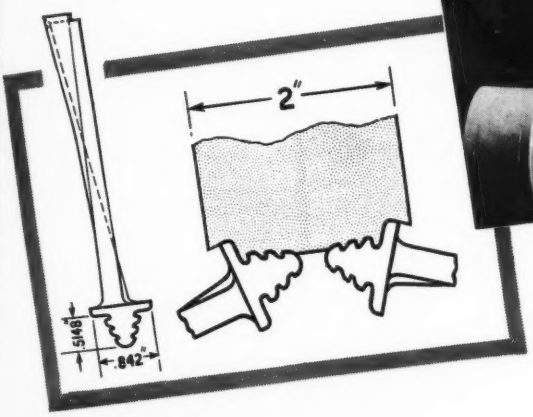
NUMBER OF PIECES PER WHEEL DRESSING: 96.
CRUSHER ROLL LIFE: 864 pieces, before regrinding Work Roll from Reference Roll to restore initial accuracy.





Thompson Truforming is an accurate and fast method of producing identical parts by transferring the shape or form of a preformed crushing roll first to the grinding wheel and then to the work. The crushing process produces a very free cutting wheel which gives an exceptionally high rate of stock removal.

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20" THROAT

Other Principal THIEL *Features*

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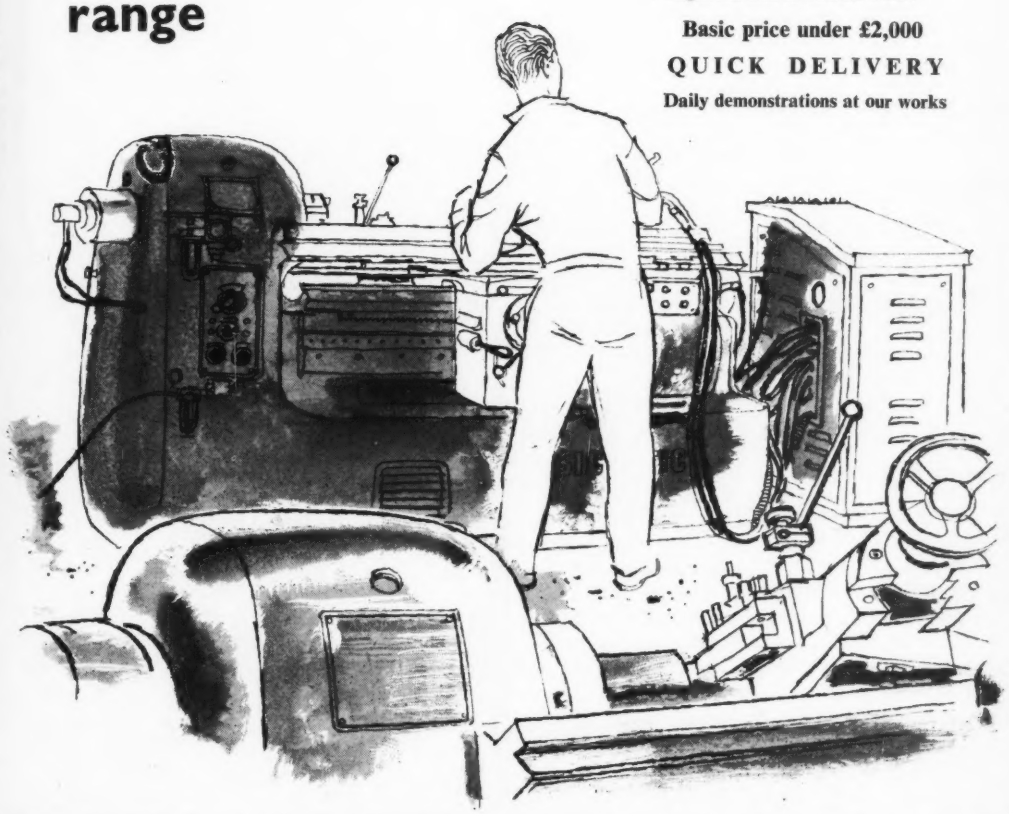

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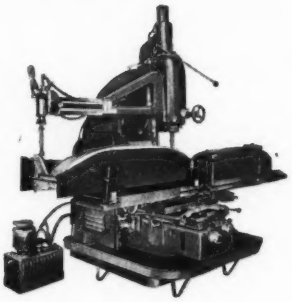
Heavy Duty Hydraulic Copying Attachments

For Milling Machines

Model FRV.

has been specially designed as a heavy duty attachment and makes use of the spindle of an existing Vertical Milling Machine, thus the full power and vertical traverse of the spindle head is available. Built in two sizes, the FRV. attachment is to be regarded as more permanent than the model FR.

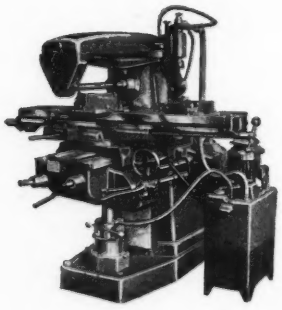


Model FR.

Suitable for fitting to an existing Plain or Universal Horizontal Milling Machine. This attachment has its own motor-driven eight-speed spindle with rise and fall quill controlled by the Hydraulic Tracer. This model is available in three sizes.

Model FRT.

is supplied in two sizes for Horizontal Milling Machine sizes 1 & and 3 & 4 respectively. The attachment is applied to the vertical traverse of the knee on the front column of the machine which is controlled by the hydraulic tracer mounted above the table.



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Brief specification:—

	Model No. 2	Model No. 3
Working surface of table	51¼in. × 11¾in.	60in. × 30in.
Longitudinal traverse	33½in.	42in.
Cross traverse	9¾in.	9¾in.
Vertical traverse	15¾in.	15¾in.
Spindle nose	No. 50 N.S.	No. 50 N.S.
12 Speeds—R.P.M.	35 to 1,520	35 to 1,520
PRICES: complete with 400/3/50 electrics and Standard equipment	**£1,745**	**£1,925**

Standard equipment includes:—Vertical Milling Attachment, Arbor Braces, Coolant Equipment, etc.

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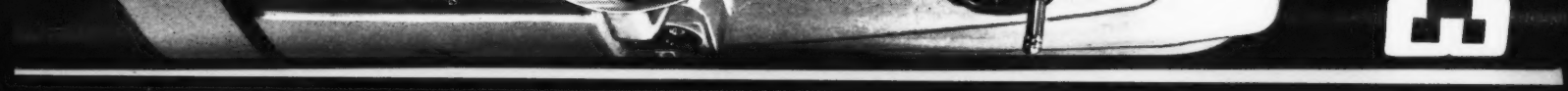

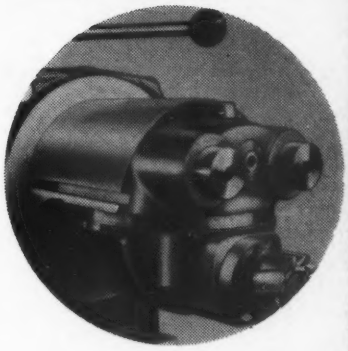

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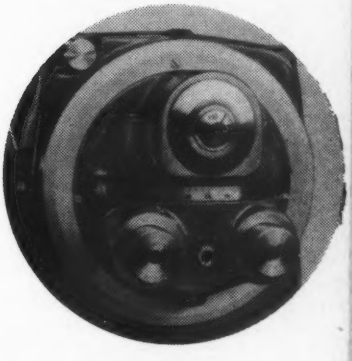

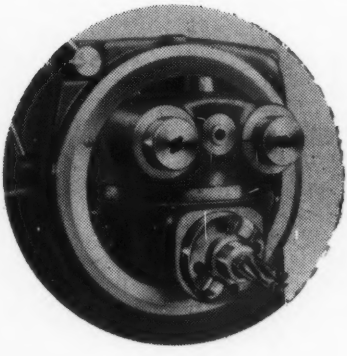

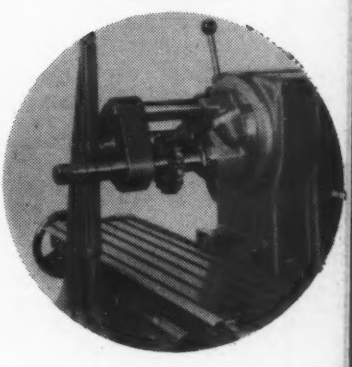

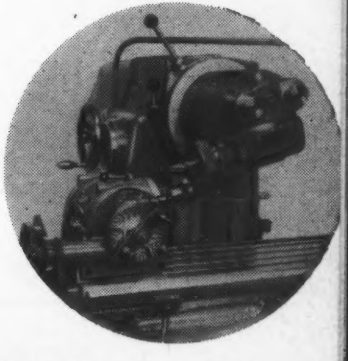

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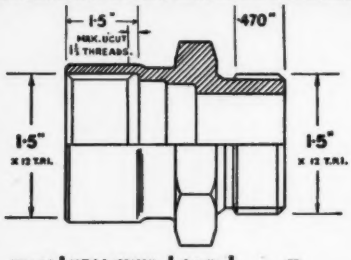
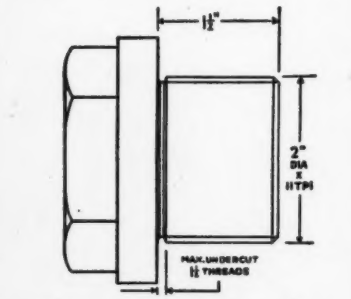


Material	H.T.S.S. (FB1006)	Spindle R.P.M.	477 Top speed available
Thread	Int. 12TPI UNF 2B Ext. 12TPI UNF 2A	Tool	Tungsten carbide
Cutting Time	Int. 55 Secs. Ext. 40 Secs.	Lathe	Willson 7½"



Material	L.A. (L65)	Spindle R.P.M.	1278
Thread	11 T.P.I.	Tool	HSS (18% Tungsten)
Cutting Time	40 Secs.	Lathe	Harrison L6

In the same way that the chasing dial has superseded the old method of marking chuck, headstock, leadscrew collar and bracket; the AINJEST HIGH SPEED SCREW-CUTTING ATTACHMENT has established a further major advance in screwcutting techniques. Its use on standard centre lathes allows the automatic engagement and disengagement of the leadscrew at the highest spindle speeds of which the machine is capable.

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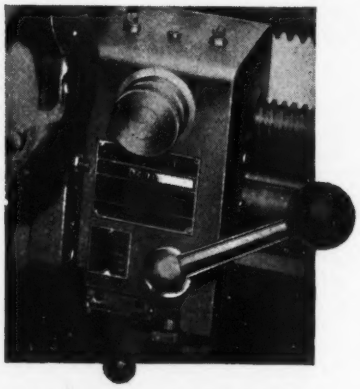

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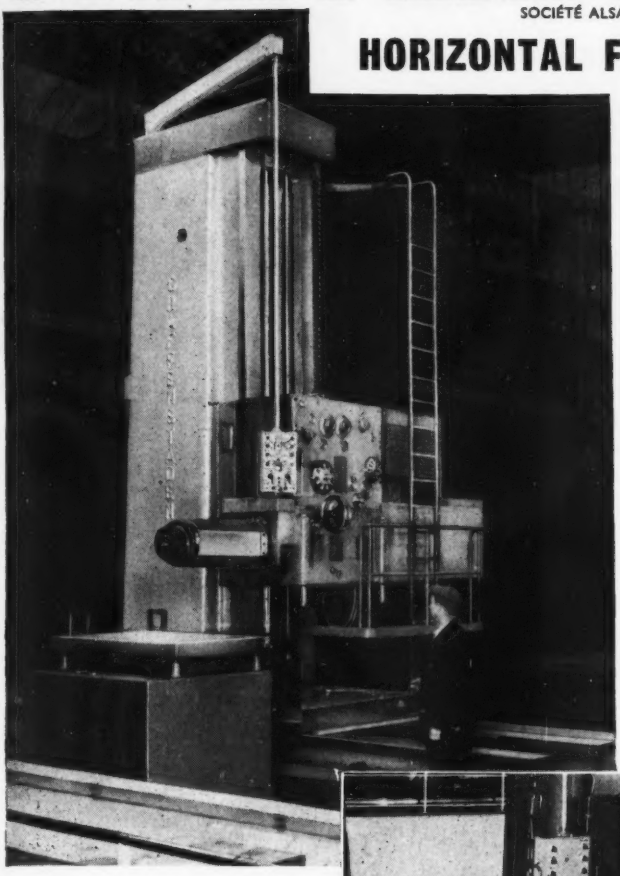

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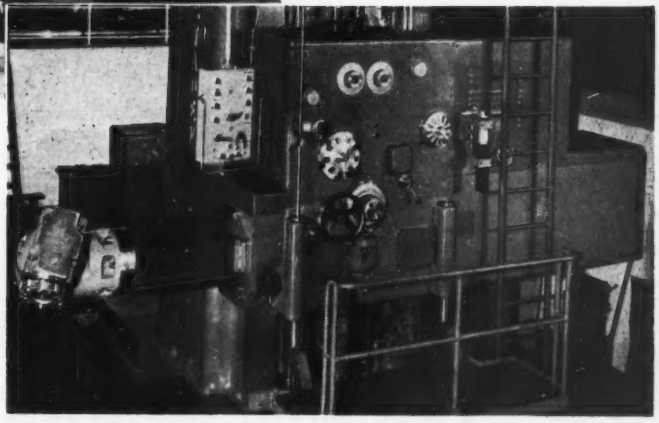

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By the Magerle method, crush formed work is now produced as easily as surface grinding.

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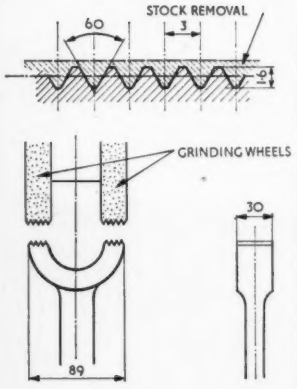

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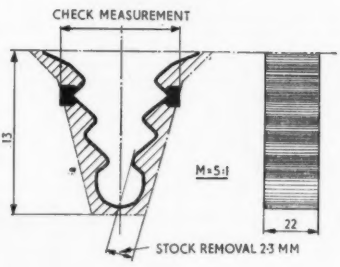

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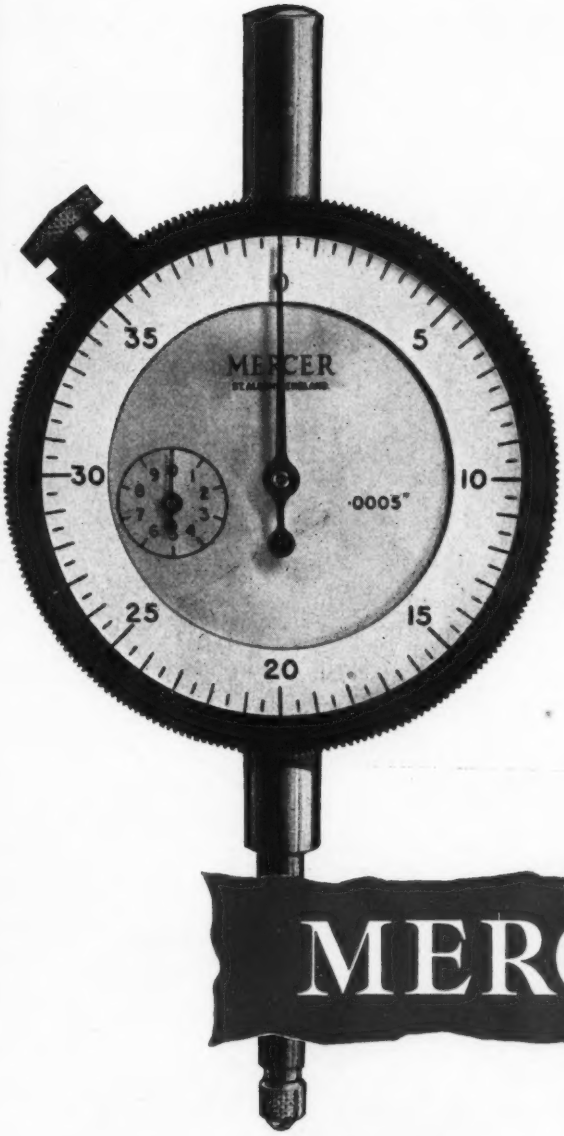

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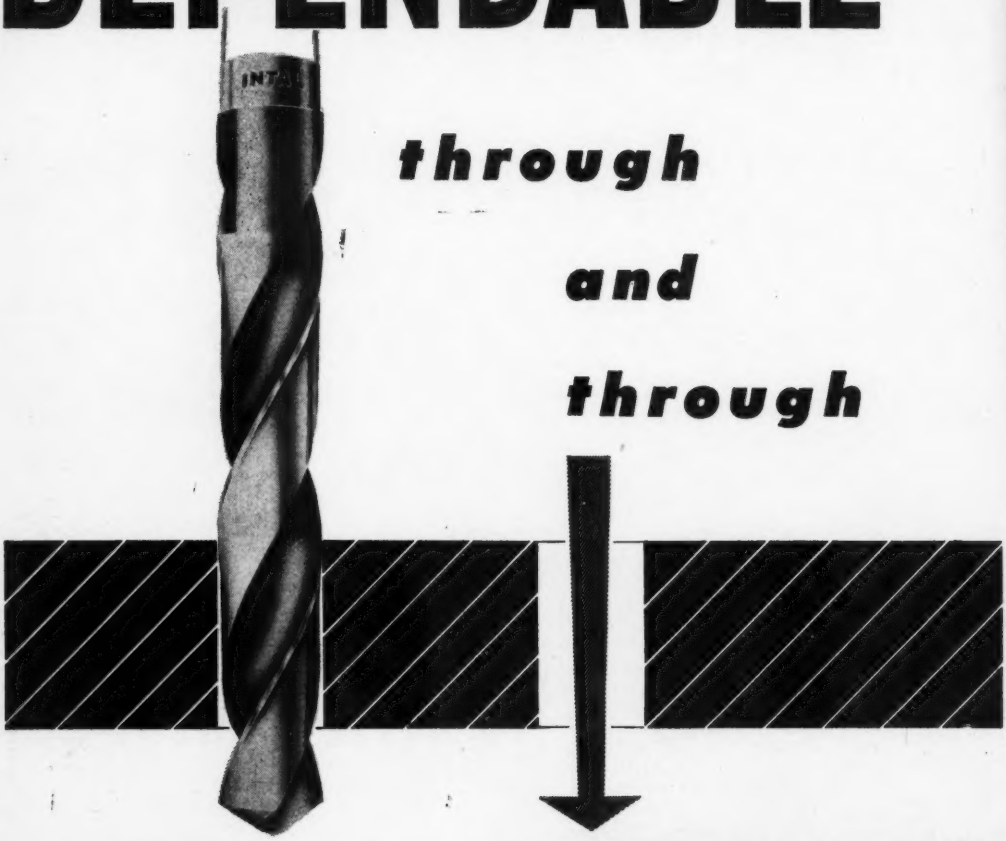

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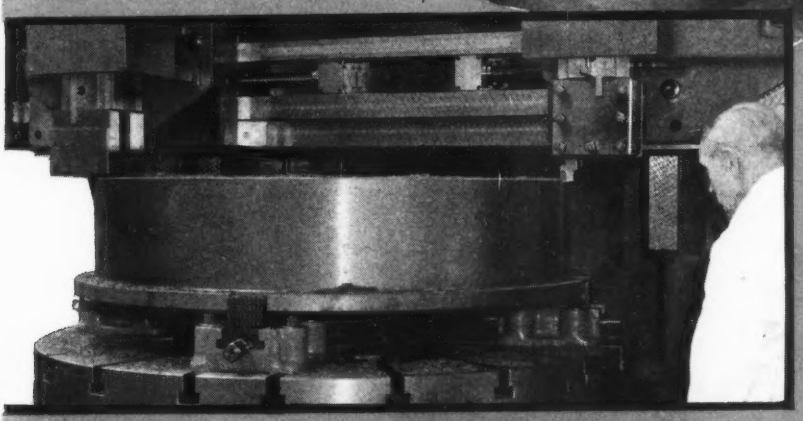

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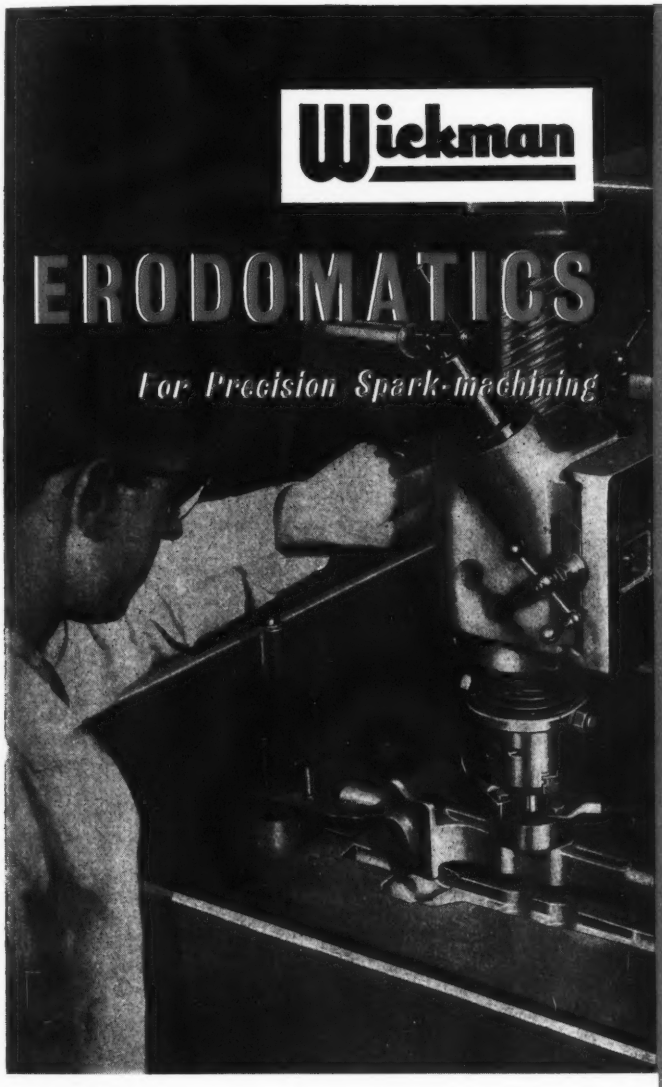

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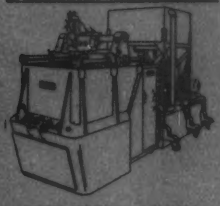

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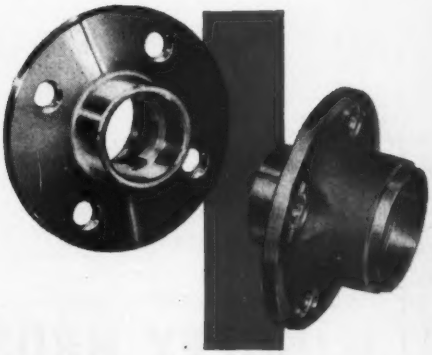

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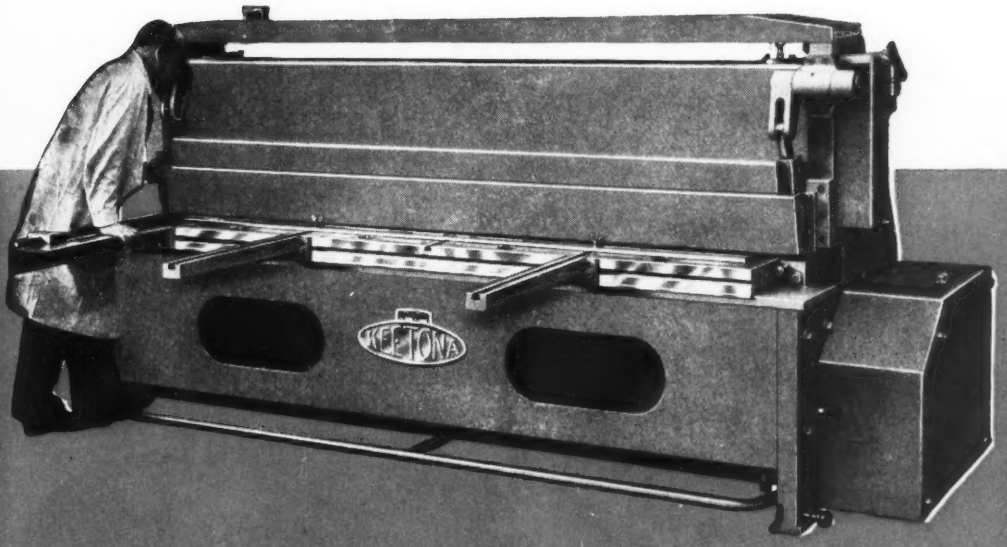

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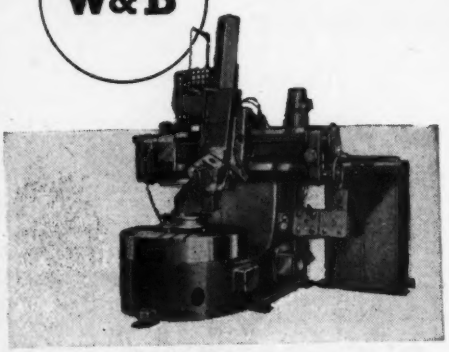

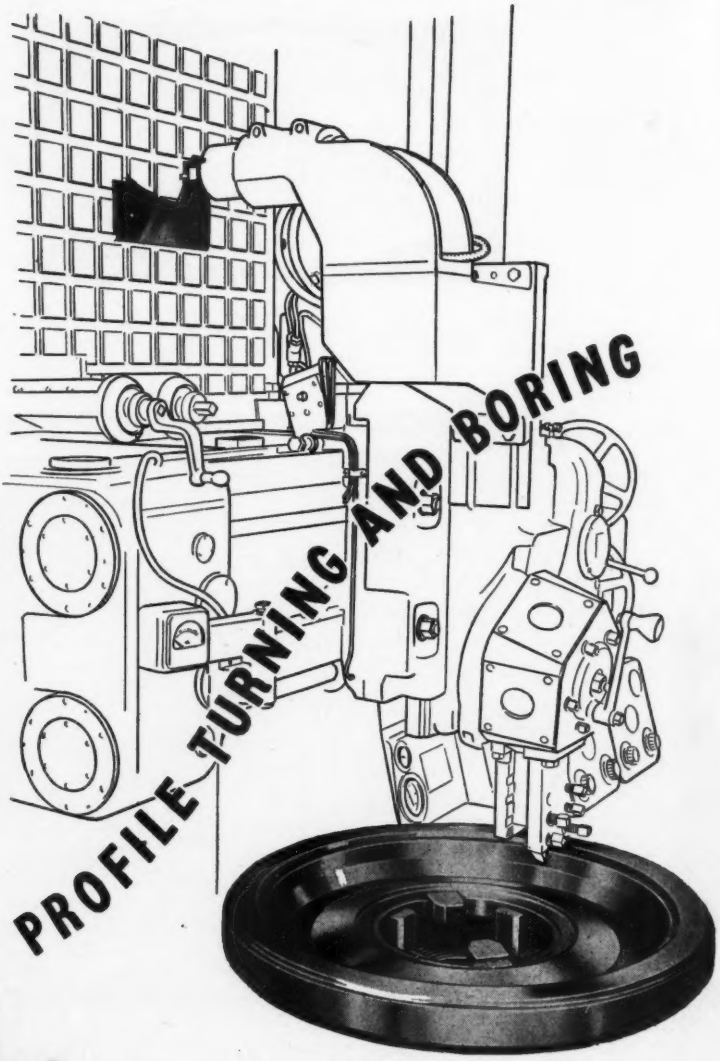

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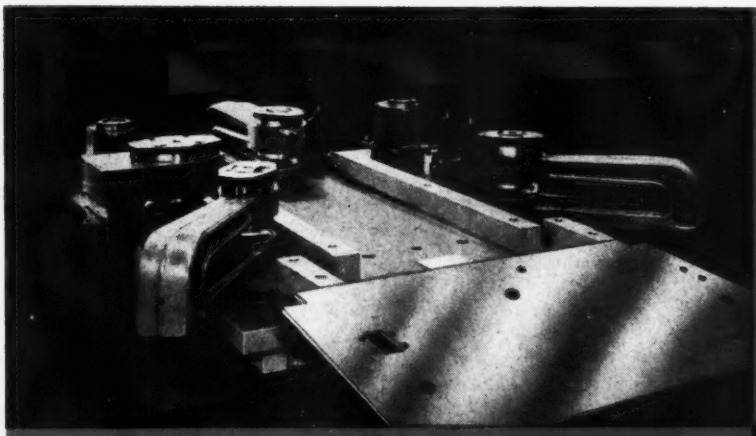

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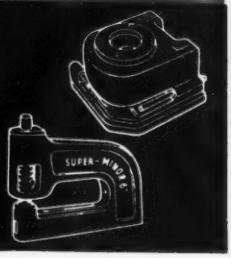

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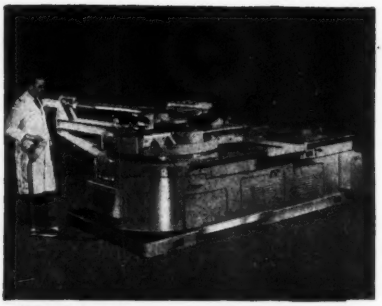

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Abstracts of Principal Articles

Refrigerator Production in Japan .. P. 176

This article, which is the second relating to the activities of the Matsushita Electric Industrial Co., Ltd., Osaka, is concerned with one of the company's 41 factories, in which refrigerators are produced at the rate of about 30,000 per month. Two sizes, of 2·8 and 3·3 cu. ft. capacity, are made in quantity, and various larger types are also produced. The refrigerator incorporates a motor-driven, sealed compressor unit, for which rotor and stator assemblies are supplied by another of the company's factories, and this article gives details of the series of operations performed on the crankcase or stator housing which is machined from an iron casting. For certain of these operations, standard machines have been effectively adapted by the company, and in this connection attention may be drawn to the use of a centre lathe for drilling and step boring, and a turret lathe for a drilling operation. On the latter machine, components are mounted on three of the turret faces for presentation to a 2-spindle adapter driven from the headstock. (MACHINERY, 98—25/1/61.)

Producing Components for Domestic Lawn Mowers .. .. P. 189

Extensive use is made at the works of Ransomes Sims & Jefferies, Ltd., Ipswich, of the induction brazing process for joining sub-assemblies. Examples are given, including the brazing of the drive shaft assembly for the Sprite motor mower, which comprises a pressed steel pulley, a short shaft with integral gear teeth, and a chain sprocket. To facilitate high-quantity production, the company has developed a 24-station indexing table whereby shaft bracket assemblies are automatically brought to the inductor coils and raised into engagement with them. Induction brazing is also used to join 16-gauge steel cylinders to cast-iron wheels, to form the land-roller assembly for the Sprite. Other operations discussed in this article include bending and twisting cutter blades, assembling cutting cylinders, and induction hardening. (MACHINERY, 98—25/1/61.)

Machine Tool Research, Design and Utilization .. .. P. 196

Abstracted from the James Clayton Lecture which was delivered before the Institution of Mechanical Engineers recently by Dr. D. F. Galloway, Director of Research at the Production Engineering Research Association, this article includes some of the more important topics discussed in a lecture that was noteworthy for its wide range and interest. Subjects discussed include examples of proposed additions to terms and definitions relating to machine tools; the study and reduction of vibration and deflection in machine tools; specially-tuned damping devices for use on boring bars and radial drilling machines; a means for measuring radial deflections of twist drills; increasing bending and torsional stiffness in main machine members by altering the positions of holding-down bolts, and the incorporation of strengthening ribs; and, hydrostatic spindle bearings. (MACHINERY, 98—25/1/61.)

Die Casting Operations at the New Factory of Thomas Ashworth & Co., Ltd., Burnley P. 205

After brief reference to the history of the Burnley firm of Thomas Ashworth & Co., Ltd., and some of the proprietary products, mention is made of the new factory in which the hitherto separated divisions of the company have recently been brought together. Gravity and pressure die casting of aluminium, and pressure casting of zinc alloys are carried out, and the pressure casting machines are connected to a Centralograph recording unit. Among the methods recently utilized for die making are spark-erosion and precision casting by outside firms. Dies for casting a control box measuring 6 by 4 by 4 in., a lamp mounting bracket with compound curvature, and a 6-in. diameter impeller, made by spark erosion, are described, also a precision cast die for a food mincing machine screw of varying pitch and sharp-edged thread form. Attention is also drawn to cam-type clamps, which provide for initially breaking open gravity dies after the castings have solidified. (MACHINERY, 98—25/1/61.)

Electro-chemical Machining .. P. 218

The process here described, which was recently demonstrated by Metachemical Processes, Ltd., involves the application of high amperages while a water-based electrolyte is pumped, at a sufficient rate to prevent boiling, through a narrow gap between the shaped electrode and the work surface. Because of the high current density rapid metal removal is obtained. The method is applicable, for example, to shaping operations on turbine blades, and equipment has also been built for cutting-off and trepanning. Reference is also made to equipment which has been introduced for the rapid application of electro-deposited coatings to work bores by the Dalic process. (MACHINERY, 98—25/1/61.)

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EDITORIAL

The Outlook for Steel

Despite the rapid recovery in crude steel production in the last quarter in 1959, and the high level of output throughout 1960, which gave a record total of 24·3 million tons for the year, the extent of the recession in 1958 and the earlier part of 1959 was such that the average production for the three years 1958 to 1960 was still below the figure for 1957. Imports of steel in 1960, it is estimated, represented the equivalent of 1·6 million ingot tons as compared with 0·5 million tons in 1959, and although direct exports reached the record total of 4·2 million ingot tons (equivalent) the increase as compared with the figure for the previous year (3·7 million tons) was smaller than for imports. Taking account of imports and direct exports, and of changes in stocks held by consumers and merchants, it is believed that home consumption in 1960 amounted to about 20·2 million ingot tons as against 17·9 million ingot tons in 1959. Of this substantial increase, it is thought, only about 150,000 tons was accounted for by a rise in indirect exports to an estimated total of 4·5 million ingot tons (equivalent).

The effect of the heavy home demand for steel on the overseas trade figures for 1960 was considerable. As compared with 1959, the rise in the value of imports of iron and steel, in the first 11 months, exceeded the rise in the value of exports by £32·8 million. In the same period there was an increase in the value of imports of iron ore and concentrates of £18·8 million, an increase in the value of ferrous scrap imports of £3·6 million, and a decrease in the value of exports of ferrous scrap and concentrates of £11·4 million. As a result the adverse balance for the 11 months was increased to the extent of £66·6 million.

It is pointed out in *Steel Review No. 21* that pressure of demand for steel and the volume and value of imports last year were significantly affected by stockbuilding. In 1959, stocks were reduced by 0·7 million ingot tons (equivalent), whereas during 1960, it is estimated, they increased by 1·1 million tons, and attention is drawn once more to the "exaggerated fluctuation in home deliveries caused by this injurious and expensive movement in steel consumers' stocks." In particular, it may be noted, imports of sheet steel during the first nine months of 1960 amounted to 550,000 tons, and during this same period the stocks of sheet held by consumers and merchants increased by 300,000 tons.

For 1960 crude steel production averaged about 93·5 per cent of the rated capacity of 25·75 million tons and for this year the estimated capacity is about 27 million ingot tons. On the basis of the evidence at present available, the British Iron and Steel Federation forecast that on average about 90 per cent of this capacity will be utilized, corresponding to an output of some 24·5 million tons. This figure, it will be noted, is only very slightly in excess of that which was achieved in 1960.

Although stockbuilding may continue, it is thought that it will be at a reduced rate, and it is not anticipated that stocks will increase during the year by more than 0·5 million tons. At the same time, no large increase in home consumption (including that accounted for by indirect exports) is expected. In the second half of 1960 there were already "indications of changes in the pattern of home demand, with orders from the motor vehicle and household durable industries easing off, and the requirements of the capital goods industries continuing to grow. Within the capital goods sector the emphasis was changing from industrial building to plant and machinery as an increasing number of companies began to install equipment in their newly built premises. These changes are likely to continue in the coming year."

Expansion of capacity, it is considered, should make it possible again to reduce imports of steel to the marginal level of 1959, also to avoid the need for imports of scrap or pig iron. It should also permit restrictions on the exports of certain products to be eased. "In spite of the fact that the immediate prospects for world demand for steel are not very encouraging, there is, therefore, good reason to hope that it may be possible for the industry's exports to exceed the post-war record level of 4·2 million tons attained in 1960."

Next year there is to be a further substantial increase in crude steel production capacity to 30 million ingot tons which will correspond to the anticipated level of demand by 1965. In particular there will be an important expansion in sheet capacity resulting from the completion of two new wide strip mills. Present plans, moreover, provide for a total steelmaking capacity in excess of 34 million tons in 1965. In this connection, the Federation comment that the industry is determined not only to meet the probable average long-

(*Continued on page 227*)

Refrigerator Production in Japan*

Methods Employed by Matsushita Electric Industrial Co., Ltd.

By R. E. GREEN, Associate Editor

A BRIEF HISTORY of the Matsushita Electric Industrial Co., Ltd., Kadoma, Osaka, was given in an earlier article† concerned with that company's new factory for television receiver production. The company owns or controls some 41 factories, with about 25,000 employees, and produces a wide variety of electrical consumer goods, also heavier electrical equipment for industrial use. Among plants owned by the company is that of the fully-controlled subsidiary Nakagawa Electric Co., Inc., at Fuse, Osaka, which has two main products. One of these products is a type-composing machine for the production of newspapers in the Japanese language, with a matrix containing the basic 2,000 characters required.

These machines are widely used in Japan, and each has a centralized casting fixture above the position occupied by the matrix holder. For producing a type character, the matrix holder is moved by a system of cams and levers, controlled by a keyboard similar to that on a Japanese typewriter, to a position such that the appropriate matrix is aligned with the casting fixture. Type metal is then injected under pressure and the cooled slug is subsequently ejected and assembled into a line of type automatically. The matrix contains all the letters in the English alphabet, and may also have Cyrillic or other characters, according to the destination of the completed machine.

Since the machine is designed for operation by means of a keyboard, it is not difficult to arrange for it to function under punched tape control, and the preparation of tape can then be carried out in an office, at a distance if necessary. The information on such a tape can then be transmitted electrically to several offices in distant towns, if required, for the preparation of further tapes, or for direct application to the type casting machines.

The other main product of the works is domestic

* Articles on the Japanese metal-working industries which have already been published in MACHINERY have been concerned with the 4th Osaka International Trade Fair, 96/1212—1/6/60 and 96/1288—8/6/60; Motor Car Production in Japan, 96/1426—15/6/60, 96/1552—22/6/60 and 96/1640—29/6/60; Bicycle Production in Japan, 97/46—6/7/60; Refrigerator Production in Japan, 97/416—24/8/60; Electric Motor Production in Japan, 97/708—28/9/60, 97/1276—7/12/60, and 97/1448—28/12/60; and Television Receiver Production in Japan, 97/932—26/10/60†. The Machine Tool Industry of Japan, 97/108—13/7/60; Japanese Machine Tool Factories, 1. Ikegai Iron Works, Ltd., 97/304—10/8/60, 2. Okuma Machinery Works, Ltd., 97/472—31/8/60, 3. Toyoda Machine Works, Ltd., 97/652—21/9/60, 4. The Kawasaki Works of Hitachi, Ltd., 97/1048—9/11/60.

refrigerators, on which some 1,400 people are employed, about 40 per cent of whom are female. The factory, seen in the heading illustration, is in a small town on the outskirts of Osaka, which is sometimes called the Manchester of Japan. It is of modern construction, and affords pleasant, clean working conditions, although some areas of the cabinet production departments might be considered overcrowded, particularly with conveyors, by Western standards. A view in the area concerned with the finishing of inner cabinets, showing the infra-red oven employed for stoving vitreous enamel on these components, is given in Fig. 1. Most of the factory floor area of about 350,000 sq. ft. is devoted to refrigerator production, type-making machines being produced in a small department at the rate of about one per month.

Refrigerators in production when the information for this article was obtained were of the company's own design, but negotiations have now been concluded with the Kelvinator organization in the U.S.A., and a technical assistance and sales agreement has been signed, with a view to raising the standard of quality and expanding markets.

Hermetically-sealed, motor-driven compressor units are employed, for which rotor and stator units are made in another of the company's factories devoted entirely to the production of small motors. Rotors are of the pressure die-cast type. Two sizes of refrigerator account for the bulk of the units produced, and are of approximately 2·8 and 3·3 cu. ft. capacity. These units are made at the rate of about 30,000 per month, and the smaller sells in the shops for the equivalent of £45.

The working week is very similar to those in other Japanese factories described in this series of articles, and the 7¾-hour day starts at 8 a.m., with 35 min. for lunch at mid-day. There is a 5-min. break in the morning and another in the afternoon, and the day ends at 4.30 p.m. Six days are worked per week, and there are 25 working days in the average month, so that current production is at the rate of about 1,200 per day. Assembly is performed on two continuously-moving tracks, one of which is employed for either of the two sizes mentioned, and normally runs at a rate sufficient for an output of 750 per day. The other track is used for 3·3-cu. ft. and larger units, and provides for an output of about 450 per day. These tracks are composed of wheeled trolleys, which support the cabinets, and are moved by variable-speed electric motors. Alongside each track, the required parts are delivered by conveyor or in containers.

ASSEMBLY AND TESTING OF REFRIGERATOR UNITS

Elaborate precautions are taken, during and after assembly, to ensure that the refrigerators will perform correctly and continuously. To this end, after the compressor unit has been joined to the remainder of the evaporator it is tested under water at a pressure of 174 lb. per sq. in. of air. Freon 12 gas is then charged into the circuit, and it is again tested under water before being taken to a room which is maintained at a constant temperature of 45 deg. C. (113 deg. F.). In this room, the unit is run continuously for a period of 2½ hours, to ensure

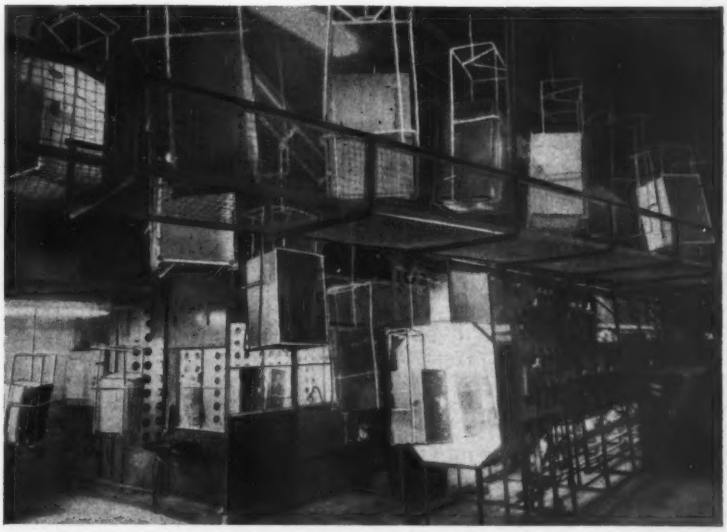

Fig. 1. A view in the Matsushita Nakagawa plant showing part of the area devoted to the finishing of refrigerator cabinet inner linings, which are carried through the electric infra-red drying oven on a continuous conveyor

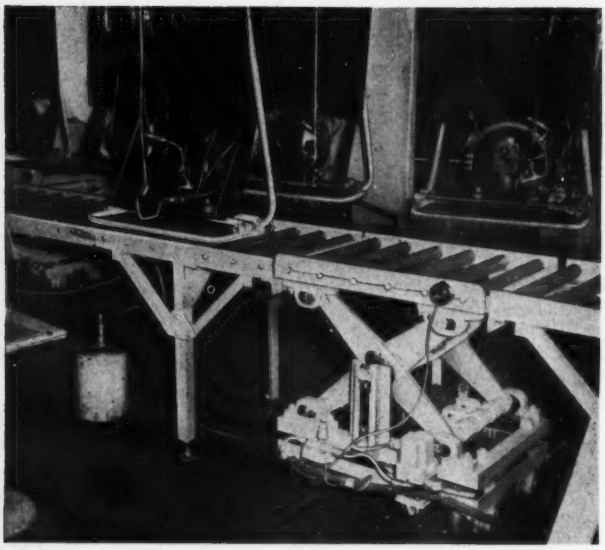

Fig. 2. At this point in the assembly line for refrigerator units, transfer is made from the roller track to an overhead conveyor by means of a movable unit. Crossed levers are drawn together by air cylinders to raise the roller track

that it is capable of removing heat continuously.

As an example of the well-thought-out arrangements for the mechanical handling of such units, which although light for a man may be considered heavy for some of the diminutive Japanese women, attention is drawn to the transfer unit shown in Fig. 2.

This movable unit is carried on flanged wheels which run on rails set into the concrete floor, and incorporates a portion of roller track, supported on the ends of two pairs of crossed levers. The levers have cylindrical projections which enter elongated holes in brackets on the base and on the under-side of the roller track portion, and are hinged together at their centres by pins fitted with slippers. These slippers run in slots formed between the opposing faces of vertical members at each side of the base. At the lower ends, the levers are connected by cross-bars, and these bars, in turn, are connected to three equally-spaced air cylinders, so that they can be brought together, as shown, or moved apart.

When the bars are moved apart, the roller track supported on the levers is lowered. After a refrigerator assembly has been moved by hand on to the roller track, the movable unit is pushed sideways by hand until a hook provided at the top of the assembly engages one of the hooks of the overhead conveyor. A button is then pressed to operate a solenoid valve which controls the air cylinders, and the roller track portion is thus lowered clear of the refrigerator assembly, which is left hanging from the overhead conveyor. The movable unit can then be returned to the position shown, ready to receive the next refrigerator assembly.

After the test in the heated room, each unit is passed through an anechoic chamber in which a noise-level test is performed. The maximum noise permitted, at a distance of 6 in. from the unit, is 38 phons. This noise level may be compared with the value of 40 phons prevailing in an

Fig. 3. The main components of the sealed compressor unit employed in the smaller sizes of Matsushita refrigerators. The piston *E*, is brazed to the steel tube *F*, which serves as the connecting rod, in conjunction with the slipper *G*

average suburban house, or 30 phons in a very quiet room, quoted in Kempe's Engineer's Year Book. Subsequently, after the refrigerating unit has been assembled to the cabinet, the complete refrigerator is again tested in one of a series of five rooms, each maintained at a temperature of 35 deg. C. (95 deg. F.), for a period of four hours. Each of these rooms has a capacity for a maximum of 40 machines at a time, and is provided with instruments which are connected to recording and test apparatus in a control room on the floor above.

For certain of the tests carried out in these rooms the starting voltage applied to the compressor motors is reduced to 85, which is lower than is likely to be encountered in Japan, where variations from the standard domestic supply voltage of 100 often occur. Most of the evaporators employed in Matsushita refrigerators at present are made from stainless steel, and are seam-welded, but some of the larger units are now being fitted with roll-bonded aluminium evaporator plates, supplied by the Showa Aluminium Manufacturing Co., Ltd.

As mentioned earlier, Matsushita refrigerators are of original Japanese design, although they follow the well-established layout employed in Western countries. The main parts of the compressor unit, which is eventually assembled, with its rotor and stator, into a pressed steel shell, and sealed by a welding operation, are shown in Fig. 3. The crankcase *A* incorporates a bored spigot to provide a bearing for the crankshaft *B*, and has a seating to receive the cylinder *C*, which carries the valve plate *D*.

As seen at *E*, the piston is brazed at one end to the side of a short length of steel tube *F*, which acts as the connecting rod and is bored to receive the slipper *G*. This slipper fits over the eccentric pin of the crankshaft, which enters through a slot in one side of the tube *F*, and the latter also has a hole which communicates with a short length of flattened tube, brazed to one side. The lower end of this tube dips into the oil in the crankcase at each revolution of the crankshaft, and picks up oil which is carried upwards by capillary action to lubricate the slipper.

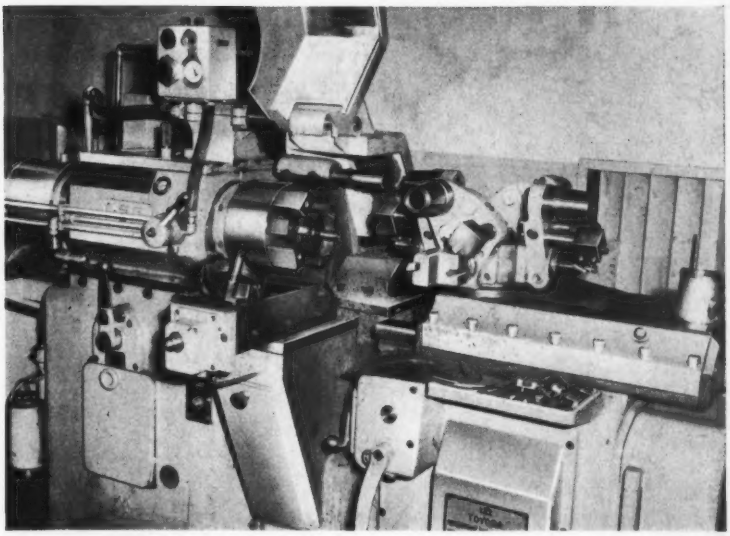

Fig. 4. The first three machines in the line for operations on crankcase castings are Toyoda ASA 9 chucking automatics. Tools on the four turret faces machine the crankshaft and stator bores

Machining operations on all these components are carried out in a single large shop at ground level, in which the machines are arranged in lines. The first three machines in the line devoted to operations on the iron crankcase casting are Toyoda ASA 9 automatic chucking machines, all equipped with similar tooling, and tended by a single operator. One of these machines is shown in Fig. 4, and it is fitted with a special 3-jaw, pneumatically-operated chuck, which has two grooved projections to provide for angular location of the casting.

The machine will swing work up to 10 in. diameter over the cross-slide, and is driven by a 7½-h.p. motor, spindle speeds from 61 to 1,500 r.p.m. being obtainable. All the tooling is carried on the 4-sided turret, the cross-slide not being used. The tools are set to bore the diameter into which the stator lamination pack fits, and to face and recess four projections at the end of this bore. In addition, the centre spigot is turned, bored and chamfered. All these operations are performed with conventional tools at spindle speeds of 264, 507, and 913 r.p.m., in a cycle time of 2 min. 10 sec.

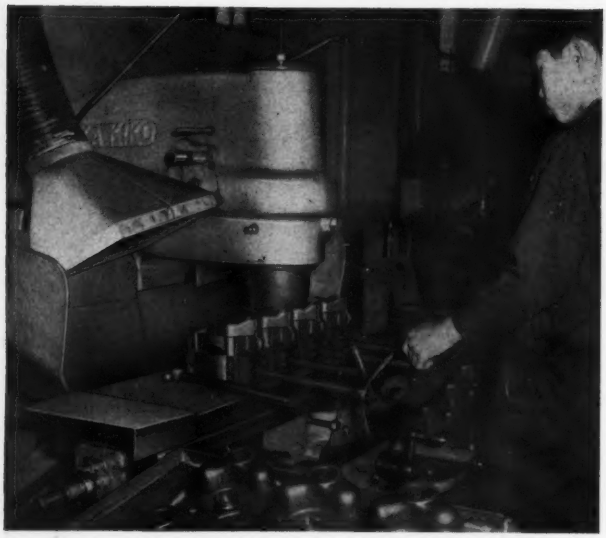

Fig. 5. This Osaka Kiko vertical milling machine is employed for facing the cylinder mounting surface and the rear end of the crankshaft bore. Castings are held on expanding mandrels in the four fixtures

FACE-MILLING AND FINE-BORING OPERATIONS

Crankcase castings are transferred from the Toyoda machines to the vertical milling machine shown in Fig. 5, which was made by the Osaka Kiko Co., Ltd., 1-4, Nishi-dori Toyosaki, Oyodo-ku, Osaka. The machine is equipped with a 5-in. diameter face milling cutter with 10 teeth, which is driven at a speed of 210 r.p.m., and is enclosed by a guard, as seen in the illustration. On this machine, the face on which the cylinder *C*, Fig. 3, is subsequently mounted, and the face surrounding the crankshaft bore, are milled on four castings at one set-up.

Each casting is placed on an arbor, which is expanded, to grip the stator pack bore, by means of a screw, fitted with a T-handle, as seen projecting from the front of each fixture. The feed rate for the milling operation is 11 in. per min. Many of the machines in this line are provided with shrouds, connected to a system of ducting through which dust generated by the machining operations is drawn out of the shop, to ensure more pleasant working conditions. Milled castings, placed on the inclined ways of a transfer chute at the left in Fig. 5, slide down to a position from which they can conveniently be taken for loading into the Toyoda type ERA fine boring machine shown in Fig. 6, for semi-finish and finish boring and chamfering each end of the crankshaft bearing.

As described in MACHINERY, 97/659—21/9/60, this machine is of conventional construction, with a bridge member at each end to carry the spindle heads and a hydraulically-operated table for feeding the work to the tools. Although the machine is

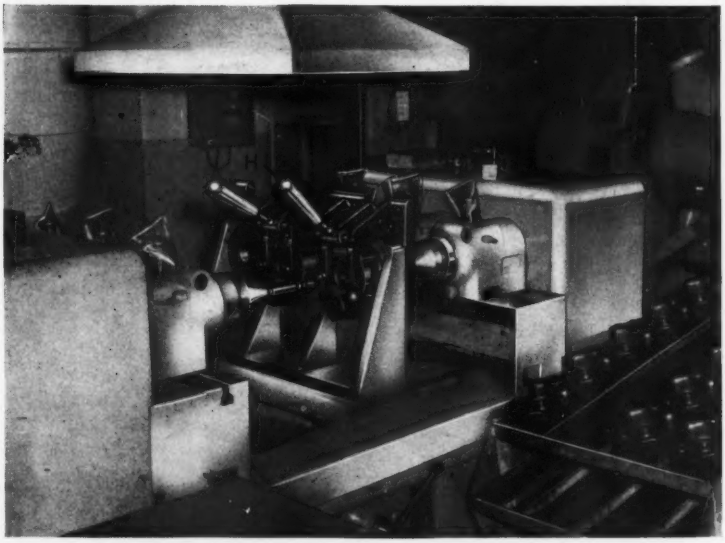

Fig. 6. Semi-finish and finish boring and chamfering operations on the crankshaft bores of two castings at a time are performed on this Toyoda type ERA machine, which is of conventional construction with a hydraulically-operated table

equipped with three spindle heads at each end, only two are in use, and they provide for taking successive cuts through the crankshaft bores of two castings at a time. The castings are loaded in a vertical position in the fixtures at the centre of the table, where each is located by the register machined in the four projections surrounding the stator pack bore, with the adjacent faces in contact with a circular plate.

A hole in the centre of the plate accommodates the central spigot of the casting, and clamping pressure is applied by two arms, hinged to brackets above each fixture. Each of these arms has an L-shaped length of round bar secured to the upper face, to form a track, and the two adjacent tracks receive rollers, which project from the sides of a clamping lever, pivoted between the brackets. This lever is fitted with a handle as at *H*, whereby the arms are moved into and out of position, and clamping force is applied and removed, and the arms are so shaped that, after the pads which they carry have been moved into contact with the casting, each roller moves over a shoulder on to a cam form.

Further downward movement of the handle then serves to apply the required clamping force to the casting, and to lock the clamping levers in position. Each of the spindles is fitted with a holder for a boring and a chamfering tool, and is driven at a speed of 2,200 r.p.m., and the table is first moved to the right under rapid traverse. A feed rate of 0·1 mm. (0·0039 in.) per rev. is employed for the semi-finish boring operation performed by the right-hand spindles, and the table is then traversed rapidly to the left for the finishing operation.

A feed of approximately 0·05 mm. (0·002 in.) per rev. is employed for finishing, and after the tools have passed through the bores, the spindles are stopped before the table is returned under rapid traverse to the central position, for unloading. At this stage, the crankshaft bore is finished to a diameter of 19 – 0·03 – 0·07 mm. (0·7480 – 0·0012 – 0·0028 in.).

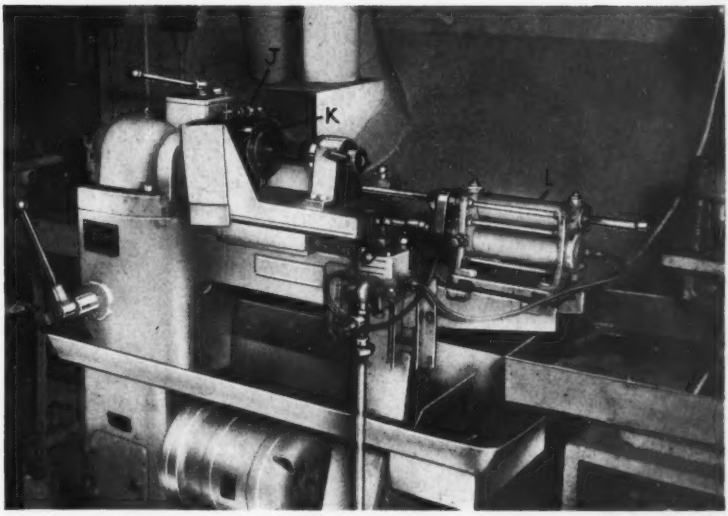

Fig. 7. Step-boring, and the drilling of a central hole for subsequent tapping, are carried out on this adapted lathe. The air-operated saddle, controlled by the hydraulic check cylinder *L*, feeds the work towards the tools which are carried in the spindle

DRILLING AND BORING OPERATIONS

Holes for holding-down bolts, locating dowels, and oil circulation, are next drilled in the cylinder-mounting face on a small multi-spindle machine made by the Fuji-Seiki Machine Works, Ltd., with the aid of a latch-type jig. Another machine is used to drill the four holes in the projection faces, which are later tapped to receive the bolts for holding the stator pack in place. The crankcase incorporates an integral pressure chamber which can be clearly seen as a bulbous projection on the castings in Fig. 5, and the next operation provides for boring and recessing the cored opening of the chamber and drilling a tapping hole at the bottom.

This operation is performed on the adapted lathe shown in Fig. 7, the saddle of which has been fitted with a clamping fixture and is traversed by means of a hydraulically-controlled air cylinder. The fixture has a vertical face at the left, with a spigot to locate the crankcase by the crankshaft bore, the casting being turned to bring one of the side mounting ears into contact with a stop *J*, which controls the angular position. Clamping is

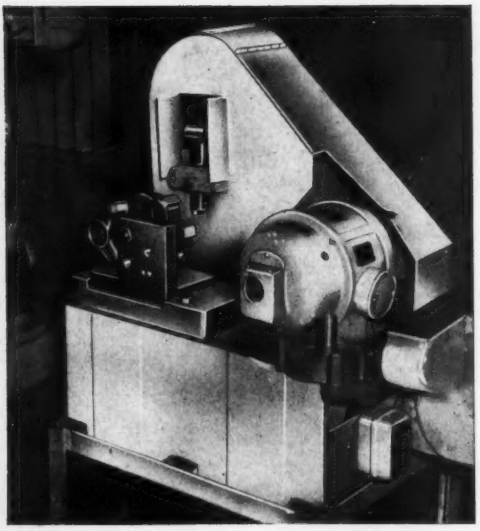

Fig. 8. On this simple home-made machine, components from a compressor are employed to impart vertical reciprocating motion to a V-shaped tool for cutting a shallow groove 0·5 mm. wide by 0·2 mm. deep (0·0197 in. by 0·0079 in.) across the face of the crankshaft spigot for oil circulation

of the machine is arranged to run at a speed of 780 r.p.m. and is fitted with boring and recessing tools and a central drill. As the casting is fed to the left by the air cylinder, under the control of the hydraulic check cylinder *L*, the hole is drilled almost to depth before the boring and recessing cutters come into operation.

SIMPLE GROOVING MACHINE

The next machine in the line, as shown in Fig. 8, is employed for cutting an oil groove, of vee form, with dimensions of 0·5 mm. wide by 0·2 mm. deep (0·0197 in. by 0·0079 in.) in one side of the crankshaft spigot face nearer to the camera in Fig. 3. This machine has a spindle head at the left, within the shroud, which is driven by the motor at the right, through a V-belt. The spindle has a plate at one end with an eccentric pin, similar to the crankshaft of the compressor in Fig. 3, and beneath the spindle the headstock carries a bracket with a bored hole to receive a cylindrical tool-holder. At the top of the tool-holder is brazed a sleeve similar to that employed as the connecting rod in the compressor, with a slot at one side through which the eccentric pin on the spindle enters the slipper—also a compressor component.

Thus, as the spindle rotates, the tool-holder is caused to reciprocate vertically, and it carries a tool of V-form corresponding to that of the required

then effected by means of the circular plate *K*, which is carried on the end of a shaft, and fits the register machined in the four projections surrounding the bore of the stator.

The shaft is held in a bush in a bracket wherein it can be moved longitudinally, and it has a pin at one side which can be engaged with a helical slot in the bush when the plate has been advanced to engage the casting. When the shaft is now turned, by means of the lever at the right-hand end, the pin traverses the helical slot, which serves as a cam to lock the casting in position. The spindle

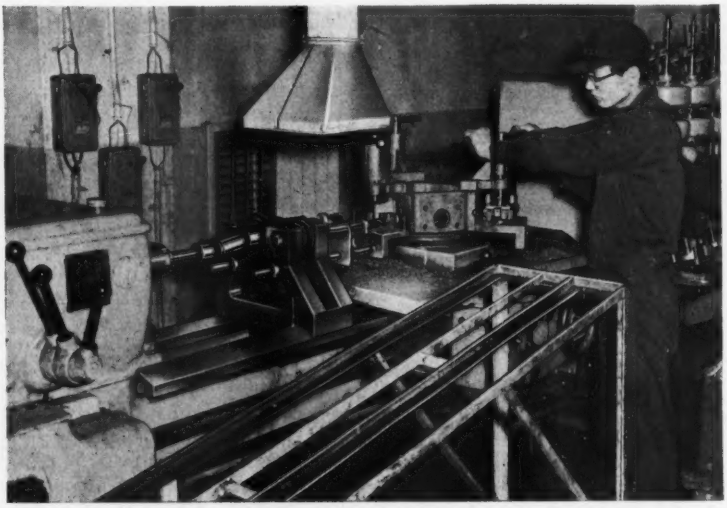

Fig. 9. Fixtures are provided on three of the six faces of the turret on this lathe, which is employed for drilling two holes in the mounting ears at opposite sides of the crankcase casting

groove. The casting to be machined is held in a vertical position on the face of an angle bracket which can be moved manually towards the tool, up to a stop. With the tool-holder reciprocating continuously, the casting is pushed forward, and with a few strokes of the tool, the groove is machined to the required depth. Further drilling operations follow, after which the two mounting ears, at opposite sides of the casting, are drilled 24 mm. (0·945 in.) diameter on the modified Kawanishi turret lathe shown in Fig. 9.

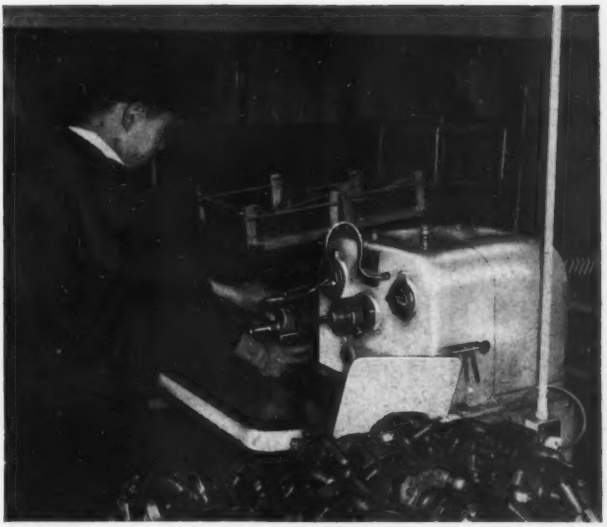

Fig. 10. The crankshaft bore is honed to close limits, and a good surface finish, under manual control, on this horizontal machine

LATHE ADAPTED FOR DRILLING OPERATIONS

As may be seen from Fig. 9, this machine has been adapted for drilling operations by fitting clamping brackets for the castings on three of the hexagon turret faces. Each bracket has a horizontal support face with a circular disc on which the casting is located by the register surrounding the stator bore. Angular location is taken from two stops on the face, which make contact with the ears to be drilled, and serve to support them against the drilling thrust. The casting is clamped by a pad on a vertical shaft which has a pin at one side. When the shaft is turned, as shown, the pin enters a helical slot in a guide bracket so that clamping force is applied.

For the drilling operation, the turret is indexed to bring a casting into position in front of the headstock, and fed to the left under power at 0·25 mm. (0·0098 in.) per rev. The drills are mounted in a 2-spindle adapter, which is clamped to the machine bed and the drive is taken from the machine spindle. In the illustration, covers have been removed to show the gearing in the adapter, which is arranged to provide a drill speed of 350 r.p.m. Drive from the spindle to the adapter is taken through a universally-jointed shaft, and the adapter is fitted with guide bars which engage bushed holes in the support brackets for the castings as the turret is fed forward. It is thus ensured that the turret will not turn under the forces applied during clamping and unclamping, which are performed during the drilling cycle.

The 27-mm. (1·063-in.) diameter by 3·5-mm. (0·137-in.) pitch thread required in each hole is next tapped on a drilling machine fitted with a 2-spindle adapter designed and made by the Matsushita company. The weight of this adapter is counterbalanced by two tension springs at opposite sides, attached to hooks on the spindle head, and the two tapping spindles are at the required centre distance for the holes drilled in the ears. The casting is held in a vertical position by engaging the crankshaft bore with a horizontal bar held in a bracket on the machine table, and can float slightly during the tapping operation, if necessary. Tapping is carried out at a spindle speed of 100 r.p.m.

This operation is the last performed in the main machine shop on the crankcase castings, which are next washed thoroughly and inspected before going to the assembly department. Here, the crankshaft bores are honed to a diameter of 19 $-0{\cdot}0025$ $-0{\cdot}000$ mm. (0·748 $-0{\cdot}0001$ $-0{\cdot}000$ in.) on the machine shown in Fig. 10, made by Fuji-Seiki Machine Works, Ltd. This machine has a spindle which is driven at a speed of 675 r.p.m., and carries a tool provided with a single honing stick and two carbide pads. A mixture of honing oil and paraffin is applied for lubrication, and the diameter of the bore produced depends largely on the skill of the operator.

Further operations on the remaining components of the compressor shown in Fig. 3 will be described in another article, to be published shortly. Articles concerned with methods and equipment employed in other Japanese metal-working plants, including those of machine tool builders, will also be included in forthcoming issues of MACHINERY.

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Thermo-plastic Recording Process

A NEW RECORDING SYSTEM, for which tape with a thermo-plastic facing is employed, has been developed by the Electron Physics Department of the General Electric Co., U.S.A. In operation, the signal to be recorded is "written" on the surface of the tape by an extremely fine electron beam, and the tape is then temporarily softened by a small heater. As the surface of the thermo-plastic facing "melts" it is deformed, or wrinkled, by the attraction between the negative charge pattern on the surface and the relatively positive charge of the base material.

The tape is then allowed to cool, and harden, so that the wrinkles are "frozen" on the surface. It is stated that the "writing", heating, and hardening process for any one scan, across the tape, can be completed in approximately 1/100th sec. The system can be employed for recording written matter, or pictorial subjects, both in black and white and colour. A checker-board pattern recorded on thermo-plastic tape is shown in Fig. 1, which is a magnified reproduction of a 0·003-in. square portion. This pattern could be used to operate a binary code system, for example, the black and white squares representing 0 and 1. With this pattern, 40,000,000 "bits" of information can be recorded per sq. in. of tape.

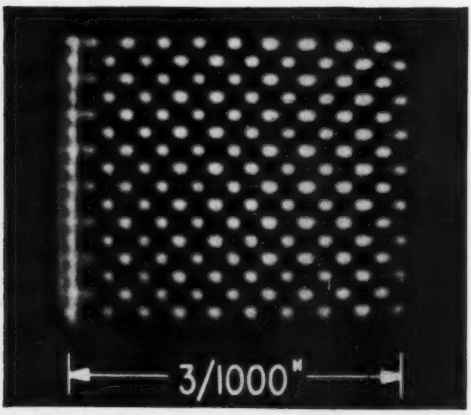

Fig. 1. This magnified section of thermo-plastic recording tape is 0·003-in. square, and incorporates black and white squares at a density of 40,000,000 per sq. in.

Fig. 2. Close-up view of part of the recording equipment, showing the supply and take-up reels, and a length of tape

When pictorial information is recorded, it can be projected from the tape with the aid of suitably modified equipment. A close-up view of part of the recording equipment is shown in Fig. 2. The base of the tape is similar to that employed for standard cine film and the strip is taken from the reel at the bottom and passed across the electron gun and the heater, and finally re-coiled on the take-up reel at the top. The equipment has a band-width which enables high-speed signals to be recorded, and it is stated that it is feasible to record and store information continuously at rates in excess of 50 million cycles per sec.

Obvious industrial applications include the storage of information in the form of micro-texts, and in this connection it is stated that a complete recording of one volume of the *Encyclopædia Britannica* could be made in approximately one min. The pattern on the tape can be erased by heating it to a slightly higher temperature than is employed during recording. The electric charge is thus dissipated and the plastics facing is smoothed automatically by surface tension.

Advantages of Numerical Control for Rocket-engine Production

By WILLIAM B. JOHNSON*

THE MANUFACTURING, DESIGN, quality control and plant engineering departments and the management of Rocketdyne, Division of North American Aviation, Inc., Canoga Park, Calif., U.S.A., are convinced of the advantages of numerical control. It is recognized, however, that if the full benefits are to be gained there must be an integrated programme from the time that the original design of a part is conceived, which covers all stages, including machining and final inspection. With such a comprehensive numerical control programme, the following steps are taken:

1. In the preliminary and advanced design stages, many possible rocket-engine design parameters are compared and evaluated so as to obtain optimum performance designs by means of computer programmes.

2. Complete mathematical-analytical definitions that express the design intention are obtained by computer programmes, where necessary.

3. Mathematical-analytical definitions are utilized to produce engineering test programmes by numerical control, which are used to check preliminary designs prior to the manufacturing phase. For example, 2- and 3-dimensional models are made for photoelastic stress analyses, also models of thrust chambers for wind tunnel tests.

4. Drawings are prepared in the best "language" for numerical control, but are still suitable for conventional processes.

5. Necessary tooling, such as master-milled templates, scribed loft boards, master-milled cams, and scribed forms for use with optical projectors, are produced by numerical control, from the original drawings, by automatic computer programmes.

6. Parts are made either directly by numerical control or by means of tooling which is produced under numerical control.

*Rocketdyne, Division of North American Aviation.

7. Parts are checked during manufacture, using optical projector forms, or master-milled inspection templates, that were produced by numerical control.

8. Parts are checked on a numerically controlled measuring machine which gives printed records, or by using another numerically controlled machine with an inspection path tape instead of a cutter centre-line location tape.

NUMERICAL CONTROL FOR RESEARCH AND DEVELOPMENT

The Canoga Park works of Rocketdyne are primarily concerned with research, development, and testing of rocket engines. Numerical control was justified in connection with research and development operations primarily on account of the need for adaptability in making prototype parts. It is a fortunate coincidence that the same tapes can be used directly for production operations.

In the rapidly advancing rocket engine industry, the emphasis is on work of a research and development nature rather than on large production runs. For this reason an adaptable system is required that will enable design changes to be quickly accommodated with the least possible cost. Only with such a system can exacting schedules be maintained.

Fig. 1. Ninety-six separate cuts are taken by this numerically-controlled milling machine on a rocket-engine injector

A machine tool that provides such adaptability is the Burgmaster 8-spindle, numerically controlled drilling, boring, and tapping machine shown in the heading illustration. Estimates made by the plant engineering department have shown that this machine more than paid for itself in savings in tooling alone in one year of operation, apart from other advantages. The machine has been operating 24 hours a day and with every part produced on it both time and money have been saved.

In several instances this equipment has made it possible to satisfy rocket-engine testing schedules that could not have been met with conventional machines. For example, on one occasion, a rocket-engine component was needed within four days to meet a testing programme. The first two days were spent in making design changes. A tape was produced on the third day and the part was machined on the fourth day. Had this item been produced by conventional methods, an additional week would have been required. Design changes on the drawing board have been incorporated in a part on a machine tool within 15 min. by merely transferring the new information to the punched paper tape.

This adaptability has been achieved by the installation of carefully-selected numerically controlled equipment. There are machines for point-to-point drilling, boring, and tapping within ±0·001 in.; for point-to-point milling and boring within ±0·0001 in.; for 3-axis milling to ±0·001 in.; and for inspecting within ±0·0001 in. Thus, the aim of utilizing numerical control from the initial design stage to final inspection has been realized. These facilities will be extended in the future under a modernization and machine replacement programme, which will be heavily biassed towards numerical control.

In the earliest stages of the Rocketdyne numerical control programme, it was recognized that employees must be trained in the principles and particularly in the electronic and mechanical aspects. A start was made in the maintenance department, with basic electronic and numerical control courses. Training in numerical control has since been extended to every department concerned.

TEAM WORK IN THE APPLICATION OF NUMERICAL CONTROL

The principle of team work is followed in applying numerical control. At the initial layout and design stages of new products, the designs are scrutinized to determine the practicability of producing the part by numerical control. This work is

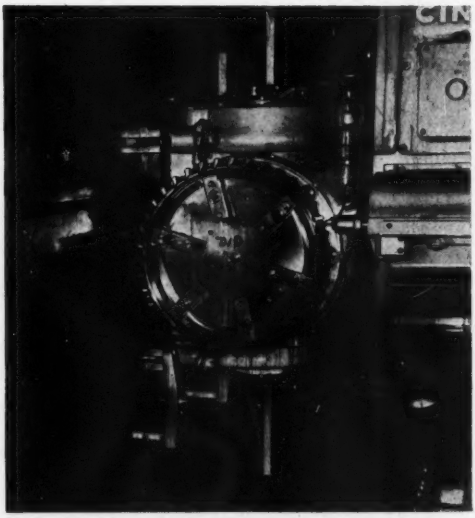

Fig. 2. This rocket-engine nozzle is machined in five weeks under the control of Remington-Rand cards

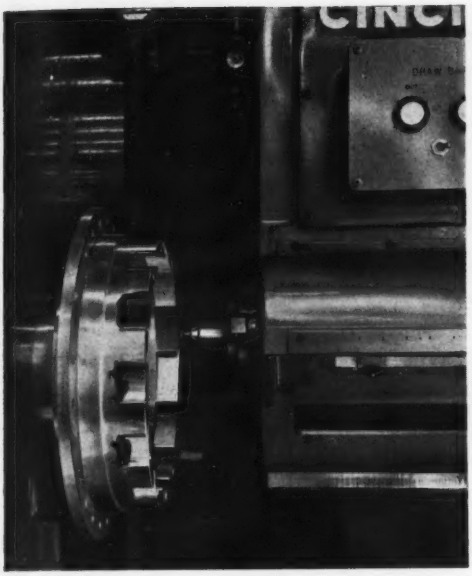

Fig. 3. Rocket-engine adapter machined under numerical control in 6 hours as against 30 hours with conventional methods

done by the production design analysis group in the engineering department. If there is a possibility of producing a part by numerical control, the pre-planning and pre-tooling manufacturing processing control and numerical control part programming representatives, with the engineering numerical analysis group, reach a decision together. Once the decision has been made to produce a part under numerical control, every effort is made by the engineering numerical analysis group to help the design group by preparing computer programmes, if necessary, to express the design intention in the best possible "language" for numerical control, both for manufacture and inspection.

The manufacturing numerical control part programming group makes the necessary planning, machining, and tooling decisions; develops layout manuscripts and computer input data; and produces the numerical control tape. At Rocketdyne APT (Automatic Programmed Tooling) is used exclusively, and 709 and 7090 IBM computers are employed to produce the continuous-path control tape. The 709 computer is a large-scale vacuum tube machine, and the 7090 is a transistorized version of the 709. When completed, the parts are inspected either by conventional methods or on numerically controlled equipment.

Part programmers and process planners responsible for numerical control machining play an important part in the success of the programme. The planners must have a complete appreciation of numerical control principles to enable them to make correct decisions as regards the machining of a rocket-engine part. They must possess a thorough knowledge of manufacturing methods, tooling, design, and the numerically-controlled machines in the plant.

NUMERICAL CONTROL—ECONOMICS AND UTILIZATION

Many examples could be quoted to indicate the savings that Rocketdyne have obtained by the use of numerically controlled machines. Fig. 1 shows an operation involving 96 separate milling cuts on the back of a large rocket-engine injector. These cuts were programmed for a Cincinnati 3-axis machine. Programming required 4 hours and the

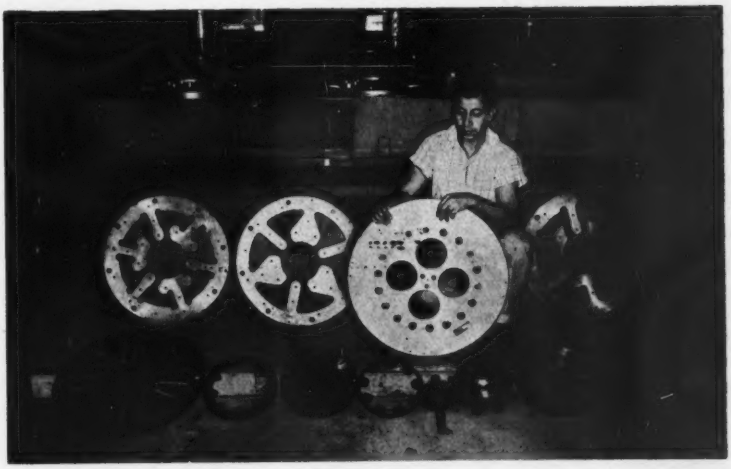

Fig. 4. Tracer templates produced under numerical control on a Hydrotel milling machine

total machining time was only 3½ hours. Movements of the various machine members were controlled by Remington-Rand cards. For the same operations, between 30 and 40 hours were required per part when the machining was carried out by conventional means. These particular items were machined in lots of three.

The heading illustration shows a rocket-engine thrust-chamber outlet ring which is machined under numerical control in 13 hours. Previously, with the aid of jigs, the part was machined on a conventional drilling machine in approximately 60 hours.

An experimental rocket-engine nozzle is seen in Fig. 2 set up for machining on a Cincinnati 3-axis milling machine. This operation, also, is controlled by means of Remington-Rand cards. Five weeks were required to machine this part from one of the so-called "exotic" metals even with this numerically controlled equipment. It may be noted, however, that an outside contractor would have required a minimum of 18 weeks to produce the nozzle on a conventional machine tool.

An integral-vane adapter for a rocket engine is seen in Fig. 3, set up on the same Cincinnati machine. The machining time was approximately 6 hours as compared with an estimated 30 hours for producing the part by conventional methods.

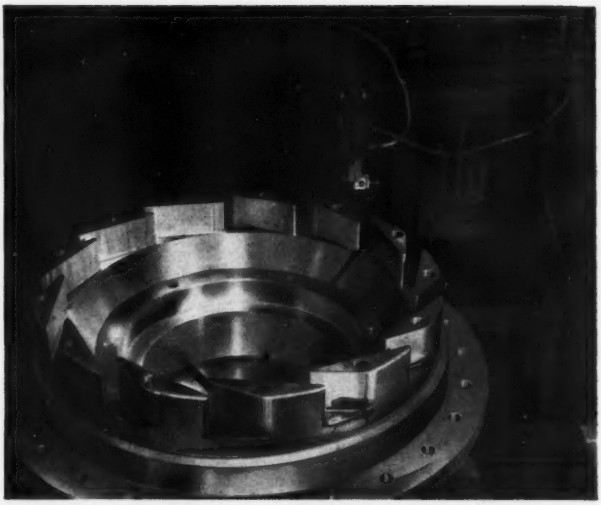

Fig. 6. Inspecting an integral-vane rocket-engine adapter on the Moore-Warner & Swasey machine

Tracer templates and tooling cams of many different forms are regularly produced from Remington-Rand cards on a numerically controlled Cincinnati Hydrotel milling machine. Some examples of these templates are illustrated in Fig. 4. They are made in one-half the time that would be required on a conventional machine.

Numerically controlled inspection operations are carried out with the aid of the Moore-Warner & Swasey measuring machine illustrated in Fig. 5, which provides a chart with all the required inspection data. In the close-up view in Fig. 6, an integral-vane rocket-engine adapter is seen set up for checking.

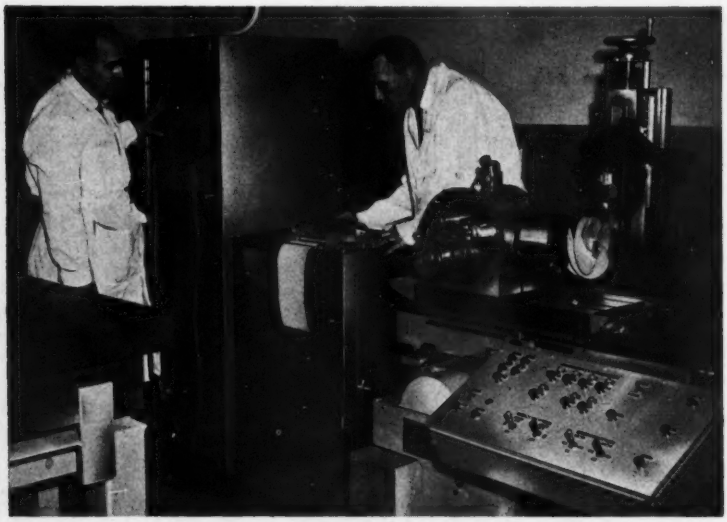

Fig. 5. Moore-Warner & Swasey measuring and inspecting machine which is numerically controlled from tape

Producing Components for Domestic Lawn Mowers

Some Further Examples of Production Techniques Employed at the Ipswich Works of Ransomes Sims & Jefferies, Ltd.

By A. W. ASTROP, Associate Editor

EXTENSIVE USE is made of medium- and heavy-gauge pressings in the construction of the Sprite and Conquest domestic lawn mowers, which are produced in large quantities by Ransomes Sims & Jefferies, Ltd., Ipswich, and the methods employed by the company for making certain components of this type were described in an article in MACHINERY, 98/60—11/1/61. Here, attention is drawn to some of the equipment installed for large-quantity induction brazing of sub-assemblies for mowers. This process is used extensively, and the company has designed and built a battery of automatic machines which are operated in conjunction with standard Radyne and Delapena electrical units.

The Sprite lawn mower is of the motor-driven type, drive being taken from a 34-c.c., 2-stroke J.A.P. engine which is mounted on top of the centre section of the main structural member. This member is made from five separate medium-gauge pressings, as was described in the article mentioned above. On the output shaft of the J.A.P. engine there is a single-groove V-pulley and drive is transmitted, by way of a belt, to a pulley on an intermediate shaft. This pulley is mounted approximately in the centre of the shaft, and at one end there is a plain spur gear portion, and at the other, a chain sprocket.

The gear portion meshes with internal teeth, cast integral with the cast iron half of the land roll, and the chain sprocket transmits drive to a sprocket on the cutting cylinder. This complete drive shaft assembly comprises three separate pieces, namely, the pulley, shaft, and sprocket, and these items are seen in the foreground in Fig. 1. The separate pieces are brazed together, by means of the rings also seen in the figure, and a completed assembly is shown in the background.

It may be noted that the pulley, seen at the left, is made from two mild steel pressings, which are spot-welded together. The periphery of each pressing is dished, to form the vee in the finished assembly, and the web of each has a raised square portion, and an embossed annular portion at the centre. A pattern of 12 spot-welds is made in the flat area surrounding the square portion, and four additional welds in the annular area. This arrangement was adopted to ensure freedom from distortion as a result of the localized heating during spot-welding.

The shaft, seen at the centre, is made from En. 8 steel, as is the sprocket at the right. Teeth on the sprocket are hobbed, and the set-up provides for cutting a stack of components at one pass. It will be seen that the shaft has two plain

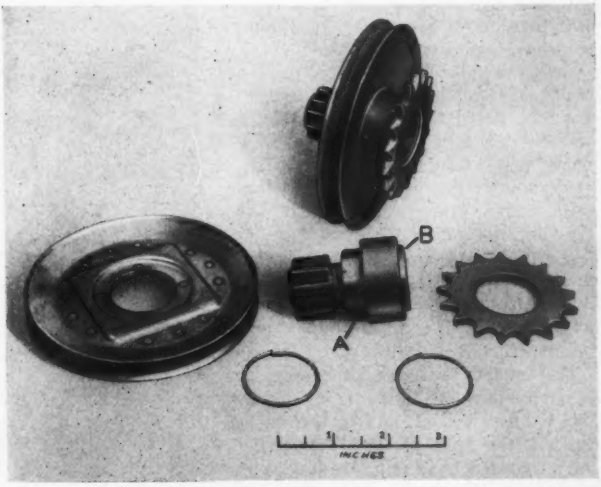

Fig. 1. The three component parts of the drive shaft assembly for the Sprite motor mower are here shown, with a finish-brazed unit in the background

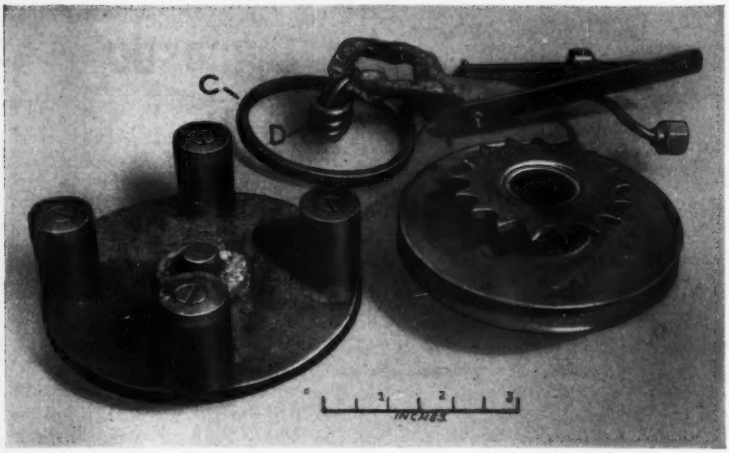

Fig. 2. The fixture and special twin inductor coils employed for brazing the drive shaft assembly

portions, at *A* and *B*, which are separated by a larger-diameter collar. A simple jig, which is employed for holding the three pieces during brazing, is shown at the left in Fig. 2, and it will be observed that it incorporates four short posts. The top surfaces of these posts are fitted with discs of Sindanyo (an insulating material marketed by Turner's Asbestos Cement Co., Ltd.) and there is another disc, of similar material, at the centre of the jig.

In operation, a pulley is placed on the fixture, so that it is supported by the four posts, and a brazing ring is laid on the upper surface, concentric with the bore. Next, the shaft is loaded, with the gear portion downwards and projecting through the bore of the pulley, and a shoulder resting on the brazing ring. Finally, the second brazing ring is dropped over the portion *B* (Fig. 1), which projects upwards from the pulley, and the sprocket is laid on top.

A brazed assembly, as it is removed from the fixture, is seen at the right in Fig. 2, and in the background, the special coaxial twin-ring inductor which is employed. The larger coil, *C*, is of such an internal diameter that it will just pass over the periphery of the sprocket, and the smaller coil *D* is designed to enter the blind bore at the sprocket end of the shaft. When the current is switched on, the assembly is heated locally, in the regions of the two brazing rings, and the two joints are made simultaneously. With this arrangement, a fully-brazed drive shaft assembly is completed every 47 sec.

AUTOMATIC BRAZING EQUIPMENT

The fixture shown in Fig. 2, in common with those for other induction-brazed sub-assemblies, is arranged to suit the special rotary indexing equipment designed and built by the company for use with the standard Radyne and Delapena units mentioned previously. A general view of one of the indexing installations, set up for brazing axle brackets for the Conquest machine, in conjunction with

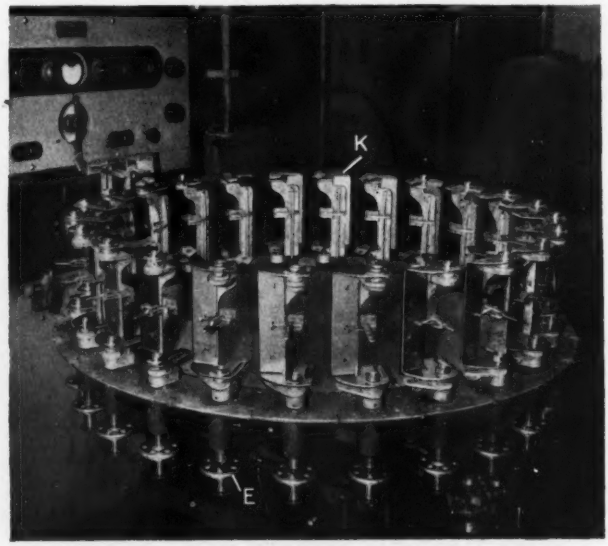

Fig. 3. General view of the 24-station automatic indexing table which was designed and built by the company to facilitate high-quantity induction brazing

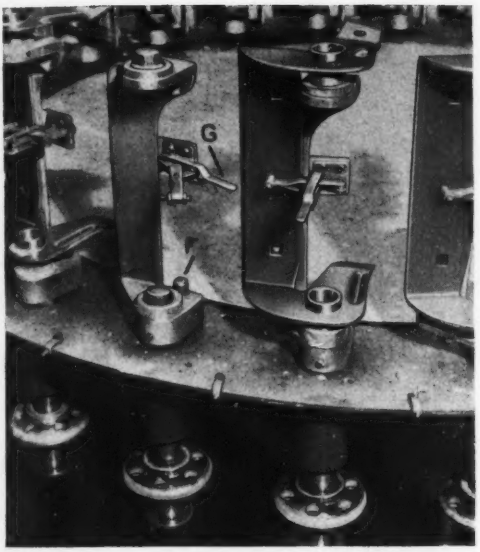

Fig. 4. Close-up view of the fixture for induction brazing a shaft bracket assembly for the Conquest machine

Radyne power equipment, is shown in Fig. 3. Basically, the equipment comprises a 48-in. diameter, 24-station table which is fabricated from ⅜-in. thick steel plate and is ribbed on the underside. This table is mounted on top of a standard Bellows air-operated indexing unit, which, in turn, is supported on a fabricated steel structure, part of the latter being seen in the foreground in Fig. 3. Provision is made for adjusting the table assembly in two directions, mutually at right-angles, to facilitate setting in relation to the inductor coils.

Spaced around the periphery of the table there are 24 vertical shafts, which are carried in plain bearings housed in steel sleeves welded to the under-side. These shafts are free to move vertically, in the plain bearings, and each has two large-diameter flanges, as at *E* in Fig. 3, which are arranged back-to-back and are secured by means of grub screws. The upper end of each shaft has a shoulder, which rests on the top surface of the table, and a reduced-diameter plain portion. This plain portion projects from the surface of the table and serves to locate and support any one of a variety of different work fixtures.

Fig. 4 shows a close-up view of part of the set-up in Fig. 3, and the work fixture at the left has been unloaded so that its construction can be seen more clearly. Machined from an aluminium casting, the fixture has a boss at the lower end, bored to suit the plain portion of the vertical shaft mentioned above, and a lug which incorporates a plain bushed hole. This hole is an easy sliding fit over the pin *F*, which is one of a number projecting from the upper surface of the table and serves to locate the fixture for angular position.

Projecting from the main web of the fixture there is a small lug, which serves as an attachment point for a standard Speetog toggle clamp, as at *G*. The fixture at the right in Fig. 4 is loaded with an axle bracket, and it will be seen that the toggle clamp is applied to the centre, to secure the bracket to the fixture. The component parts of the axle bracket, before brazing, are seen in Fig. 5, and comprise a 10-gauge pressing and two mild steel bushes. These bushes are brazed into the plain holes in the end flanges of the pressing, and the brazing rings can be seen in the foreground. Referring again to Fig. 4, the bushes are located by Sindanyo plugs, incorporated in the aluminium fixture, and are positioned axially by shoulders on these plugs.

Successive indexing movements of the table bring each fixture to the brazing position, and a close-up view of this area is shown in Fig. 6. Here, it will be seen that there are two coaxial inductors, *H* and *J*, which project from the front of the Radyne unit. Attached to a fixed portion of the table assembly, and coaxial with and below the inductor coils, there is a vertically-mounted double-acting air cylinder, and as each fixture is brought to the brazing position air is admitted to the head

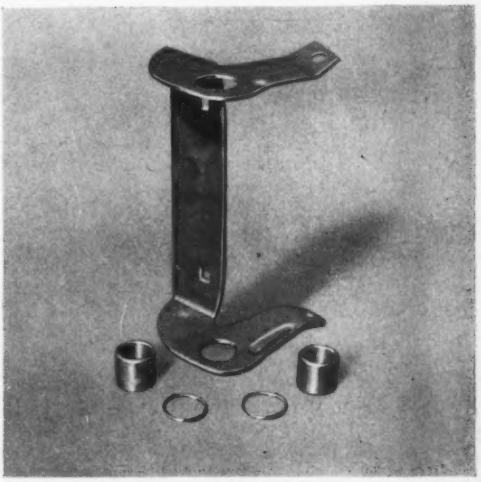

Fig. 5. The component parts for the shaft bracket incorporated in the Conquest machine

end of this cylinder. As a result, the ram is extended and abuts the bottom end of the vertical shaft carrying the fixture. The shaft is thus moved approximately 1½ in., to raise the work into the inductors.

The vertical air cylinder is energized, to raise the work, when the flange *E*, Fig. 3, closes a micro-switch during the final stages of the indexing movement. When the vertical shaft is raised, the flange *E* contacts a second micro-switch—immediately above the other—to switch on the current supply to the inductors. An electric timer, whereby the current is automatically switched off at the end of a predetermined period, also serves to operate a solenoid valve to reverse the air supply to the vertical cylinder, and the work is thus lowered to its original position.

Next, the table is automatically indexed, to bring the next fixture to the working position and the cycle is repeated. Angular positioning is ensured by an air-operated plunger, which is raised to engage with a bushed hole in the under-side of the table, adjacent to each fixture station. The operation of this plunger is also automatic, and it is interlocked electrically with the operating cycle. Another interlock is provided to ensure that the table cannot be indexed if the fixture is in the raised position.

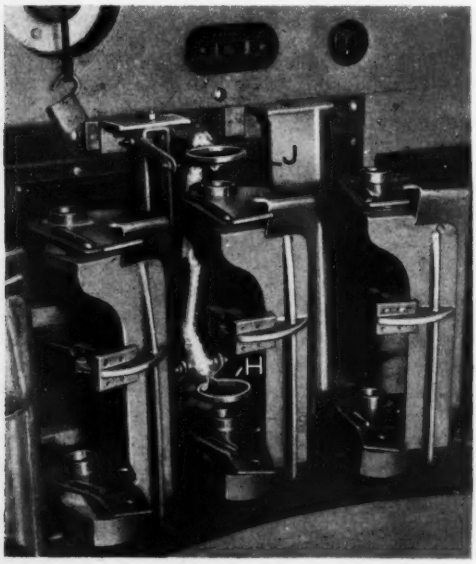

Fig. 6. Close-up view of the twin inductor coils employed for induction brazing two plain bushes to a steel pressing

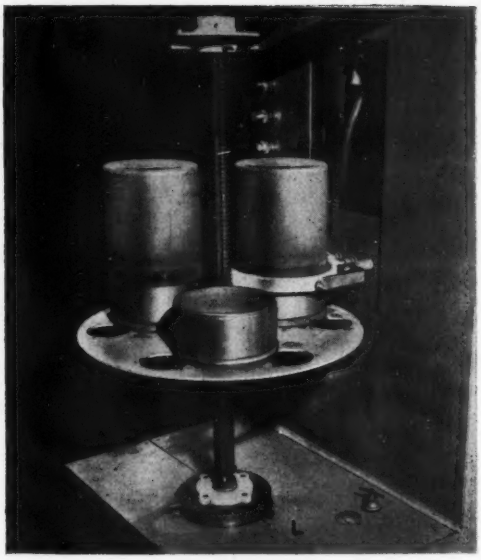

Fig. 7. Set-up for induction brazing steel cylinders to the land-roll gear of the Sprite motor mower

The operator normally stands at the far side of the table, as viewed in Fig. 3, and loads and unloads the work at the position indicated at *K*. By the time the parts reach this position, they have cooled considerably, and they are removed and placed in a large tank of water. From this tank, they are passed to other areas for further operations in the manufacturing sequence.

BRAZING THE LAND-ROLL ASSEMBLY FOR THE SPRITE

Another interesting induction brazing set-up is employed for assembling the land-roll for the Sprite motor mower. This item comprises three separate pieces, namely, a 16-gauge sheet steel cylinder (with one closed end), a heavy cast-iron roll, with integrally-cast internal gear teeth, and a disc-shaped cast-iron balance weight. The latter is secured inside the steel cylinder, at the closed end, by means of three screws, but the roll casting is located, by means of a spigot, in the open end of the cylinder and is joined to the latter by brazing.

A general view of the brazing equipment is given in Fig. 7, with two fully-assembled land-rolls, ready for brazing, in the background. In the foreground is seen a cast-iron roll, without its steel cylinder, and the machined spigot is clearly

visible at the upper end. The cylinders are deep-drawn, from high-quality drawing steel, and before they are brought to the brazing equipment, a stress-relieving operation is performed on the open end. The latter is heated locally, over a length of about 1½ in., and the cylinder is then allowed to cool before being forced, closed-end foremost, through a simple sizing die. This operation, which is performed on a Hi-Ton hydraulic press, restores the open end of the cylinder to a circular form, and it is then ready for brazing.

The equipment shown in Fig. 7 incorporates a simple circular table on which three assemblies are located, and the electrical equipment was supplied by Delapena & Son, Ltd. Provision is made for raising and lowering the table, by means of the screw seen at the centre, and the complete unit is mounted on an air-operated indexing mechanism housed in the base portion *L*. With this equipment, the work remains at the same height and the inductor head is lowered, to bring the coil to the required position, and then raised to allow the table to be indexed. The brazing ring is slipped over the spigot on the cast roll before the steel cylinder is assembled, and the latter, with the balance weight already attached, serves to hold it in position. As mentioned earlier, the steel cylinder is of 16-gauge material, and the thickness of the cast roll in the region of the spigot is of the order of $\frac{1}{16}$ in. Despite the dissimilarity in the materials, and the thicknesses, a continuous circumferential joint is made, without waviness or distortion, in a cycle time of 37 sec.

It may be noted that the equipment shown in Fig. 7 is semi-automatic, the operator being responsible for initiating the cycle after a finished part has been removed and the station reloaded. Induction brazing is employed for several other assemblies incorporated in the Conquest and Sprite machines, for example, for attaching the filler tube and outlet port to the petrol tank of the latter. In developing the various techniques, the company has co-operated closely with Johnson Matthey & Co., Ltd., who supply all the special brazing rings and flux employed.

MAKING BLADES FOR CUTTING CYLINDERS

One of the most important factors determining the quality of performance of a lawn-mower is the number of blades in the cylinder, which, in conjunction with the speed of rotation, determines the number of cuts per yard of forward movement. The average domestic lawn mower has six blades, but machines for high-quality work, as required on bowling and golfing greens, have as many as 10 cutting blades. Regardless of the number of blades, the basic design and construction of the cutting cylinder unit is the same. There are three main parts—the spindle, the collars, and the blades—and these items are assembled by welding. Simple jigs are employed, and an example of such equipment, which provides for locating and clamping the spindle and collars in the required positions, is shown in Fig. 8.

Three angle plates, as at *M*, have V-notches in their upper edges, to locate the spindle, and a reduced-diameter portion of the latter, at the end remote from the camera, enters a hole in the block *N*. The shoulder on the spindle abuts this block, and provides for axial location. Before the spindle is loaded into the jig, the three collars are threaded on, and are subsequently pushed along until they abut the sides of the angle plates *M*. Projecting from each angle plate there is a small-diameter pin, as at *P*, and these pins are spaced angularly in relation to each other to suit the helix angle of the cutting blades. One slot in each collar is engaged with this pin. Clamping pressure is applied to the assembly by means of the handle at the left-hand end of the jig.

This handle is connected to a horizontal shaft, which extends along the far side of the jig and has a coarse-pitch threaded portion at the left-hand end. At the right-hand end, the shaft is supported

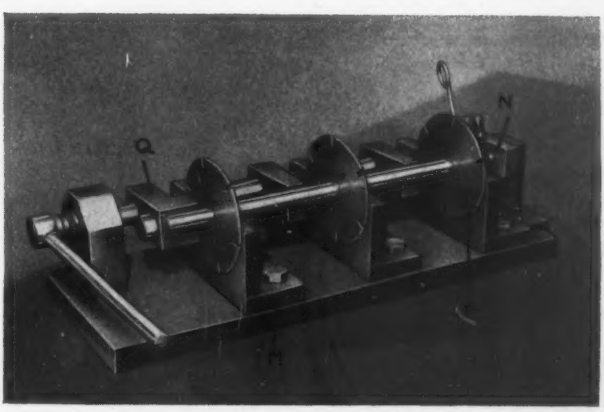

Fig. 8. This simple welding fixture provides for locating and clamping the spindle and collars of a cutting cylinder

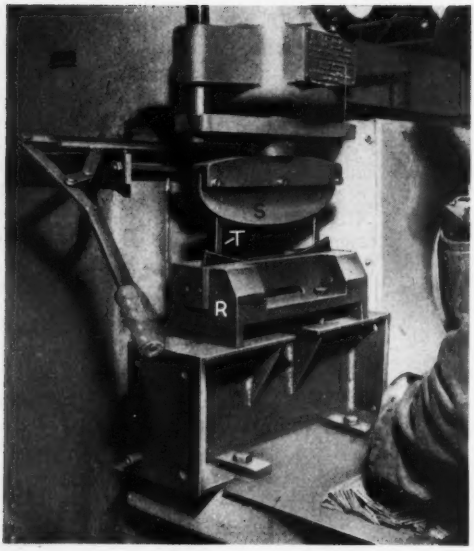

Fig. 9. Prior to the twisting operation, the cutter blades are formed to an accurate shape at this set-up on a Hi-Ton press

in a plain bearing, and it carries three clamping pieces, as at *Q*. These items are keyed to the shaft, and in the free end of each there is a heavily spring-loaded plunger. For loading, the handle is turned away from the camera, with the result that the clamping pieces are swung away from the fixture, and the complete shaft assembly is moved axially, to the left.

When a workpiece has been loaded, the handle is turned to the position shown, with the result that the clamping pieces are engaged with the collars. Continued movement of the handle forces the collars against the angle plates, the spring-loaded plungers ensuring that all are securely clamped. The three collars are then welded to the spindle by conventional hand methods.

BENDING AND TWISTING CUTTER BLADES

The blades are bent, and twisted to the required helical form, on special equipment which has been developed by the company. Made from steel of special section, the blades are first bent to an arcuate shape in the tools shown in Fig. 9, which are mounted on a Hi-Ton hydraulic press. The bend is made in the plane of the blade width, and is carried out on two blanks at a time. A stack of blanks, already cut to the required length, can be seen in the foreground in Fig. 9, and they are of special knife-edge section.

A pair of blades, placed back to back is placed in a slot in the fixture *R*, from which they project by approximately ¾ in. When the press is operated, the ram thrusts the curved member *S* down on to the top edges of the blades, and forces them into an arcuate seating in the fixture *R*. In Fig. 9, a pair of formed blades is seen in the fixture, after the ram has been raised. Removal of the blades is facilitated by the provision of two strips *T*, which are attached to the curved member *S*. The bottom ends of these strips are hooked, and as the ram rises they engage the formed blades and partially eject them from the fixture.

It may be noted that the handle seen at the extreme left controls a safety latch, which must be released before the ram traverse can be started by means of a push-button at the right of the machine. With this arrangement, the operator is compelled to use both hands to start the press.

From the press set-up seen in Fig. 9, the blades are passed to an adjacent special-purpose machine which provides for twisting them, two at a time, to

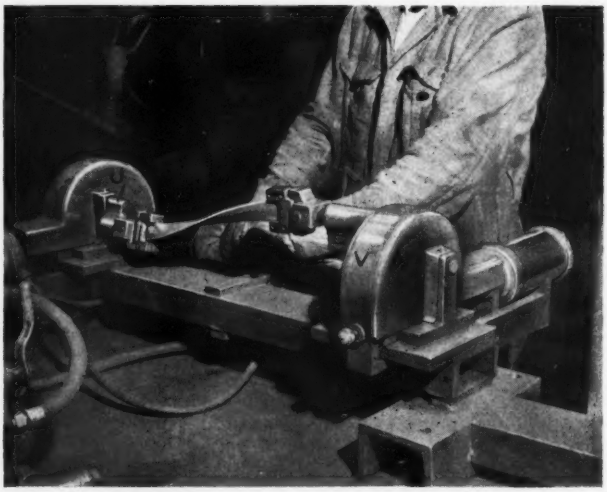

Fig. 10. Pairs of cutter blades are twisted to the required helical form on this special purpose machine designed and built by the company

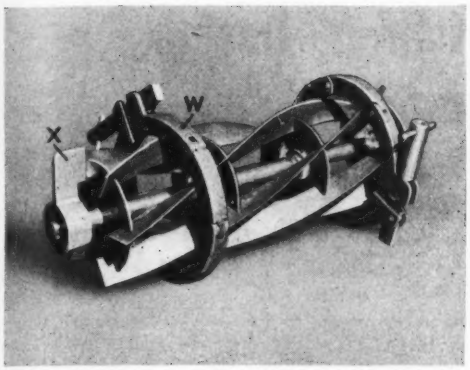

Fig. 11. For final welding, the blades are retained by special ring-type clamps

the required helical form. A close-up view of this machine, which was designed by the company, is given in Fig. 10, with a pair of twisted blades in position. The machine has a pair of cranked arms, as at *U*, each mounted on a horizontal shaft which can be turned by an air-operated rack and pinion housed in a cover, as at *V*.

At the free end of each cranked arm, there is a simple form of universal joint, which has a slot-type seating of a shape to suit the end section of two blades, arranged back to back. In the loading position, the cranked arms are so disposed that a pair of curved blades can be introduced readily into the seatings in the universal joints, this operation being facilitated by the flexible nature of the latter units. Movement of a lever-type valve admits air to the two cylinders, and the two cranked arms are then turned in opposite directions, to produce blades of the twisted form seen in the figure.

ASSEMBLING BLADES FOR WELDING

Blades are fitted to the previously-welded shaft and collars by hand, and an assembled cylinder, ready for welding, is shown in Fig. 11. The blades drop readily into the slots in the collars, and are retained in position, for welding, by a pair of special ring clamps, as at *W*. Each clamp is made up from five separate arcuate pieces, hinged together by plain pins, and incorporates an eye-bolt type clamp. When the clamp is tightened, the ring contracts, to squeeze the blades into the bottoms of the slots. Axial positioning is checked with the simple gauge *X*, which is slipped over one end of the spindle and can be turned freely by hand. The gauging face is aligned with the end of each blade, in turn, and the latter is tapped lightly to the required axial position. Finally, the clamps are fully-tightened, prior to welding.

After they have been welded, the assemblies are transferred to the grinding shop, where the blades are ground cylindrically on a battery of special heavy-duty Churchill machines. It may be noted that all cutting blades are hardened prior to grinding, some by means of the induction method on a group of BTH machines. A close-up view of the working area of one of these machines, with a high-quality cutting cylinder in the working position, is shown in Fig. 12.

The cutting cylinder is held vertically, and is free to rotate under the influence of two pairs of rollers which are mounted above and below the heating coil. These rollers engage the sides of one blade, and as the cylinder is moved vertically it is simultaneously turned. At the end of each pass, the cylinder is automatically indexed to bring the next blade into line with the rollers, and the cycle continues. It may be noted that this hardening equipment is double-ended, provision being made at the other station for the hardening of individual bottom blades.

Further articles, describing some of the machining and casting methods employed at the Ipswich and Nacton works of the company, also the flow-line assembly of the Sprite and Conquest machines, will be published shortly in MACHINERY.

Fig. 12. Close-up of the BTH equipment for induction hardening cutting cylinders

Machine Tool Research, Design, and Utilization*

By D. F. GALLOWAY†, B.Sc. (Eng.), Ph. D., Wh. Sch. (Member of Council)

MODERN MACHINE TOOLS are often designed to transcend the mental and physical resources of human operators, and to avoid the errors and limitations imposed by human fallibility and fatigue. Inevitably, such machines are complex mechanisms, and it follows that machine tool research and development are also complex, and involve the identification and consideration of a large number of factors and criteria relevant to the machines and to their utilization.

* Abstracted from the James Clayton Lecture delivered before the Institution of Mechanical Engineers on December 14, 1960.

† Director of Research, Production Engineering Research Association, Melton Mowbray.

CRITERIA OF MACHINE TOOL PERFORMANCE

The selection of a machine tool should be based on the overall efficiency and economy of the service that it will render to the manufacturing unit. For this reason, the final basis for selection must be economic, and it follows that decisions on design, development, and utilization must also be determined by an economic yardstick. Practical research must therefore be related to the economic requirements of machine tool users, and must provide for the machine tool designers the type of information which will enable them to satisfy users' demands.

TABLE I. ABRIDGED TABLE SHOWING VARIOUS FACTORS INFLUENCING THE CRITERIA BY WHICH THE PERFORMANCE OF TURNING TOOLS CAN BE ASSESSED

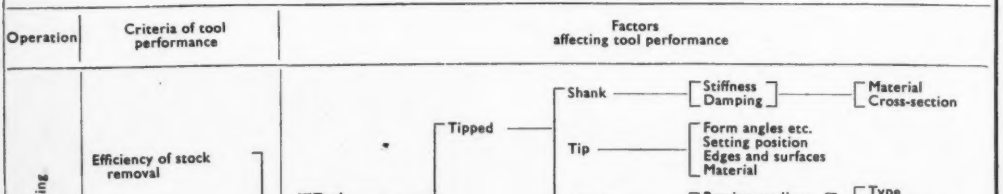

TABLE 2. EXAMPLES OF PROPOSED ADDITIONS TO TERMS AND DEFINITIONS RELATING TO MACHINE TOOLS

Term	Definition or description	Significance
Static stiffness	$\frac{\text{Applied static force}}{\text{Deflection at point of application of force}}$	Accuracy and rate of elimination of initial workpiece errors
Variable stiffness characteristic	Ratio of maximum to minimum static stiffness over traverse length of machine	Reduction of workpiece profile errors
Dynamic stiffness*	*Definition A* True spring constant of machine structure at mode of vibration considered *Definition B* "Complex" spring constant of machine structure at mode of vibration considered	Resistance to shock loading, forced vibration and self-excited vibration
Dynamic magnifier	Ratio of amplitude of vibration at resonance to static deflection	Damping of structure in relation to vibrational forces
Vibrational stability	Speed at which chatter occurs with specified overhang and cutting conditions	Ability of machine to suppress self-excited metal-cutting vibration or chatter
Stick-slip parameter	$\frac{\text{Static friction}}{\text{Kinetic friction}}$	Accuracy of positioning of machine slides

* The need for the introduction of the term dynamic stiffness is widely recognized but different definitions are being considered in different countries.

The determination of the economic requirements of users, and the evaluation of the economic performances of machine tools, are often based on *qualitative* assessments. Consequently a useful contribution can be made by machine tool research in the establishment of *quantitive* methods of assessment. The economics of various types of machines, and schemes of utilization, can then be assessed with reasonable accuracy on a factual basis, independently of personal opinion and conjecture. In practice, this procedure involves the identification of various technical criteria which facilitate the measurement of the overall economy of machining operations. Moreover, the factors which influence these criteria must be determined, and by investigations must then be made into the nature and magnitude of the influences they exert. Charts of such criteria, and their associated influencing factors, are obviously required as a starting point for research, and a typical chart, in abridged form, is shown in Table 1. This chart applies to turning operations on a lathe, and the second column shows seven criteria of tool performance—three for rough machining and four for finish machining.

In the right-hand portion of the table are shown the various factors which can affect tool performance, and the complexity of the research required is apparent. Charts such as that shown in Table 1 can be drawn up for operations involving most types of machine tools, and whereas many of the criteria and associated factors are common for different types of operations and machines, their significance varies. For example, considerations of accuracy and stability for precision grinding machines are different from those for radial drilling machines.

New facilities for the identification, measurement and control of the factors and criteria associated with the performance of machine tools are continually being developed, with the result that there is increasing scope for comprehensive mathematical treatment of the behaviours of machine tools and cutting tools. Fundamental theoretical analyses can thus be used to indicate targets for the performances of machine tools, and the actual and theoretical performances can then be compared, on a realistic basis.

TERMINOLOGY AND SPECIFICATIONS FOR MACHINE TOOLS

Like many other branches of engineering, and particularly the related field of cutting tools, machine tool engineering is beset by problems of inadequate and inconsistent terminology and specification. Some less familiar machine tool terms and definitions which should be brought into everyday use for machine tool specification are set out in Table 2. In particular, the establishment of more clearly defined limits of accuracy, alignment, vibration, and efficiency, for example, would benefit machine tool technology considerably, not only from the standpoint of users, but also from that of builders.

Some recent researches have shown the need for

TABLE 3. EXAMPLES OF PROPOSED ADDITIONS TO CONVENTIONAL ACCURACY AND ALIGNMENT TESTS

Additional test	Principal factors to be controlled	Measurement or observation	Test criteria
Metal-removal	Work material, tool, dimensions of cut, cutting speed	Rate of metal removal, input horse-power	Specific metal removal rate
Elimination of profile errors (especially with reference to grinding machines and boring machines)	Work material, tool, dimensions of cut. Specially-shaped workpiece giving variable depth of cut. Size of workpiece in relation to machine capacity and method of support. Number of cuts	Residual deviation from final profile after given number of cuts	*Residual deviation from final profile* Intended change in profile for a cut of specific dimensions
Vibrational stability	Work material, tool, dimensions of cut, cutting speed, shape, size and method of support of workpiece	Incidence of chatter Position of tool in relation to work	Speed at which chatter occurs with specified overhang and cutting conditions
Vibration level	Spindle speed, engagement of machine movements	Amplitude of relative vibration between tool and work support	Amplitude of vibration
Surface roughness	Work material, tool, dimensions of cut, cutting speed, cutting fluid Spindle speed	Surface roughness of workpiece	Surface roughness of workpiece
Bearing temperature	Spindle speed, running time	Ambient temperature Temperature rise	Temperature rise in 1 hour above ambient temperature at given speed
Accuracy of positioning of machine slides	Lubricant; load on slide (zero to maximum work load); gib adjustment; sliding speed	Incidence and magnitude of stick-slip Sliding speed Slide movement	Lowest speed at which smooth sliding or a specified small amplitude of stick-slip is obtained Smallest effective in-feed increment which can be applied

more adequate specifications for machine tools than are at present in use. The charts issued jointly by the Institution of Mechanical Engineers and the Institution of Production Engineers, between 1940 and 1948, served as a useful beginning, but experience and research in recent years have shown that they now require considerable modification and extension. Revised tests and tolerances can be established as the result of co-operation between machine tool builders and users, and research and standardization organizations. Extensions to the accuracy and alignment charts of the I.Mech.E. and the I.Prod.E. might include, for example, data on vibration characteristics, metal removal rates, and surface finish of the workpiece. A few examples of proposed additions are given in Table 3.

At present, specifications for machine tools include practically no quantitive data on deflection and vibration characteristics, two factors which can vitally affect efficient operation. It might be desirable to specify that on a centre lathe, for instance, a standard test piece which is gripped in the chuck, and is unsupported by the tailstock, should be machined without chatter, under prescribed conditions of power consumption and tool shape. The dimensions of the test piece could be suitably related to the leading dimensions of the machine.

Delays which occurred in producing machines capable of exploiting the potentialities of ceramic tools reflected the comparative inability to assess, quantitatively, the deflection and vibration characteristics, and to control these phenomena by proper design and utilization. The curves in Fig. 1 show the chatter vibration characteristics

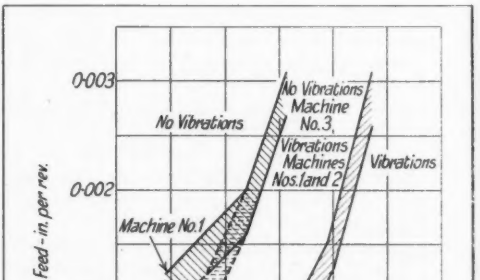

Fig. 1. Curves showing the regions of vibration for three different lathes when machining 5-in. diameter by 15½-in. long steel test pieces at 360 r.p.m. The curves are related to feed rate and tool nose radius

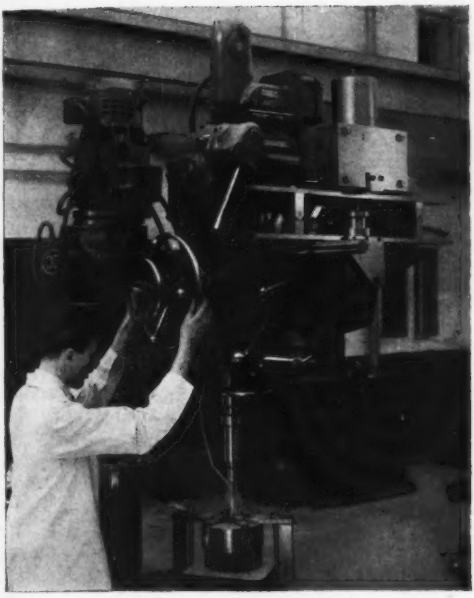

Fig. 2. This radial drilling machine has a specially-tuned absorber fitted to the free end of the arm, to reduce vibration during a particularly difficult spot-facing operation

of three different lathes in terms of feed rates and tool-nose radii, and represent typical research results. In each instance, the test piece was of steel, 5 in. diameter by 15½ in. long, and the spindle speed was 360 r.p.m.

VIBRATION OF MACHINE TOOLS

Vibration in machine tools can be classified under three broad headings, namely, vibration response to applied excitation; vibration when running light; and vibration when machining. To determine the first-mentioned characteristic, known vibrating forces are applied at selected points, for example, at the spindle, and the response is measured at other points, for instance, columns and bases. In this way, the principal modes of vibration, and the natural frequencies of these modes, can be determined in any given machine tool.

Vibrations when running light are determined by a process of elimination, readings being taken at various points with the various mechanisms and drives running either separately, or simultaneously. To measure vibrations when machining, records are taken at various positions on the machine tool under different conditions of feed rate, spindle speed, and depth of cut, for example. It is not alway practical, or convenient, to improve the vibration characteristics of a machine by increasing the rigidity, but valuable contributions can sometimes be made in this respect by fitting tuned and damped vibration absorbing devices.

Work in this connection was carried out some years ago by the Cincinnati Milling Machine Co., who fitted an absorber within the over-arm of a horizontal milling machine. A similar device is shown applied to the free end of the arm of a radial drilling machine, in Fig. 2. This absorber was tuned to suppress chatter vibration which occurred during a difficult spot-facing operation. Records of the vertical vibrations of the drill head with (above) and without (below) the absorber are shown in Fig. 3. Without the absorber, the amplitude of the vibrations of the head were of the order of 0·016 in., and severe chatter marks were formed on the surface of the workpiece, as seen at the left in Fig. 4. With the absorber fitted, however, the amplitude of the vibrations was of the order of 0·005 in., and the surface finish was improved, as shown at the right.

Troublesome vibration is also frequently experienced in connection with overhung boring bars, since the maximum diameter of the effective portion of the bar is inevitably determined by the diameter of the hole to be machined. With conventional boring bars, chatter vibration commonly occurs if the ratio of diameter to length exceeds 5 to 1, with the result that surface finish is unsatisfactory and tool life is reduced. The experimental boring bar shown in Fig. 5, however, has a diameter to length ratio of 10 to 1 and

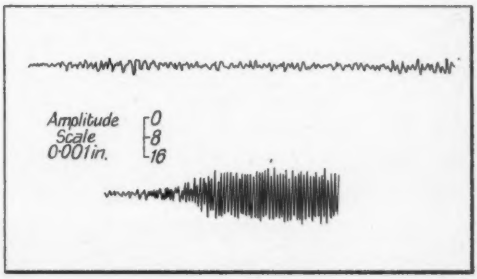

Fig. 3. These traces show the vibration of the head on the drilling machine in Fig. 2. With the absorber (above) the amplitude of the vibrations is of the order of 0·005 in., whereas without the absorber (below) the amplitude is approximately 0·016 in.

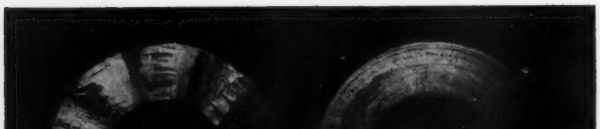

Fig. 4. Examples of spot-faced surfaces produced on the machine shown in Fig. 2, without the absorber (left) and with the absorber (right)

is fitted with a special vibration absorbing device, which is located immediately behind the tool.

The free end of the boring bar has a blind hole, and is internally threaded to receive the tool holder. A mass A, of calculated weight, is attached to the back of the tool holder by a flexible-type connection, and is housed within the blind bore. The latter is filled with oil, to act as a damping medium, and vibration traces from a bar in the undamped and damped conditions are shown above and below, respectively, in Fig. 6. These traces were obtained during machining operations on high-duty aluminium alloy, with a fine feed and a depth of cut of 0·005 in. The amplitude of the chatter vibrations in the unstabilized bar was of the order of 0·036 in., peak-to-peak, and the marked reduction achieved as a result of fitting the stabilizer is clearly indicated. Improvement in surface finish obtained by the use of the stabilized boring bar is indicated in Fig. 7, where enlarged views of portions of the bore of the high-duty aluminium-alloy workpiece are seen.

A wider understanding of vibration tests and techniques, and practical application of the experimental results would lead to significant improvements in machine tool design and more effective inspection procedures. An important object of research into vibration is the determination of suitable parameters which, when related to types of machines and working conditions, will provide a reliable guide to the limits likely to be imposed by vibration on machine utilization. This aspect is of great importance in connection with machines which are required to produce components to close limits, and with

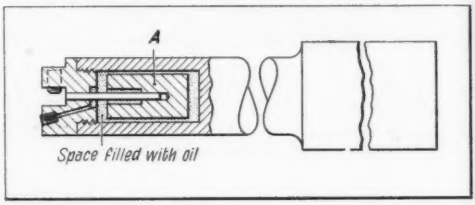

Fig. 5. Diagrammatic sectional view of a boring bar which incorporates a tuned absorber. The diameter to length ratio of this bar is 10 to 1

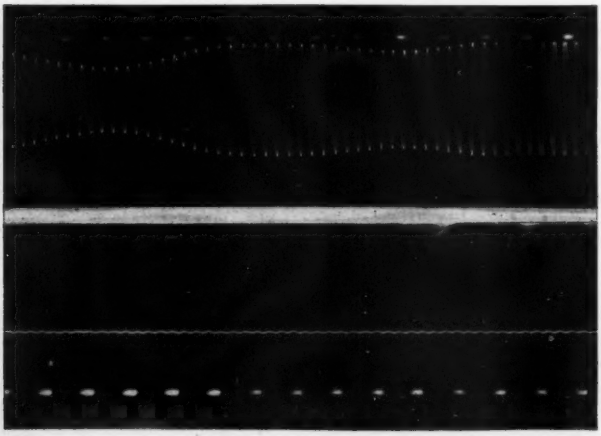

Fig. 6. Vibration traces of unstabilized (above) and stabilized (below) boring bars when machining high-duty aluminium alloy

exceptionally high surface finishes and textures.

For many years, quantitive data on the deflection of machine tools under working conditions was very limited, but recently extensive experiments on a wide range of machines, of both British and foreign origin, have provided a comprehensive picture of machine distortions and vibrations and have revealed a number of common

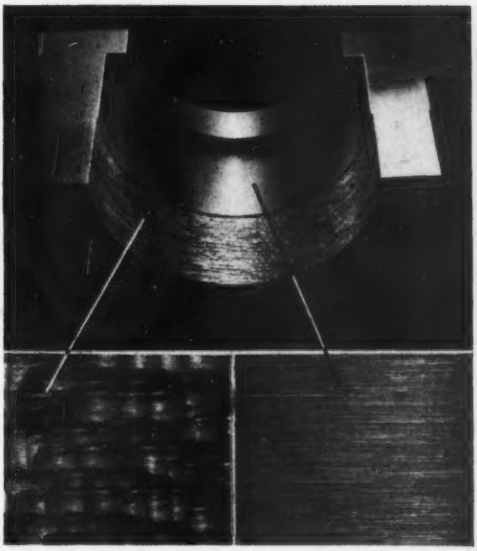

Fig. 7. Surface finishes obtained when boring a high-duty aluminium alloy workpiece with an unstabilized bar (bottom left) and a stabilized bar (bottom right)

weaknesses which can be remedied. Some of these tests have already been described in papers by the author concerned with radial drilling machines and lathes. In connection with the latter, attention is drawn to the design of the tailstock shown in Fig. 8, which has important advantages to offer from the standpoint of resistance to deflection. It will be seen that the "barrel" portion is of trapezoidal section, with the major axis vertical, and taper adjusting gibs are incorporated to permit adjustment for wear. Curves showing the vertical

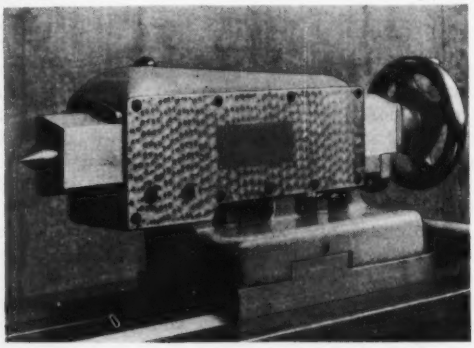

Fig. 8. The use of a trapezoidal-section quill on this tailstock greatly improves the resistance to vertical deflection

deflections of the quills of tailstocks of conventional and new designs are shown in Fig. 9 for various applied loads.

Flexural movements of machine tool elements often have to be considered in conjunction with other movements resulting from the accumulation of minute degrees of slackness in bearings and slides, for example, also deflections in workpieces, tools, and associated holding devices. It has been shown that even when drilling operations are performed on high-quality machines, the accuracy and alignment of the holes produced are affected to a marked degree by deflections arising from the structural weaknesses of conventional twist drills. The nature and cause of some of these deflections have been examined experimentally and analytically with the aid of equipment as shown in Fig. 10. This equipment enables the radial deflections of a drill to be measured while it is entering the workpiece, and the information obtained is set out in the form of a polar chart.

Referring to Fig. 10, it will be seen that there is a

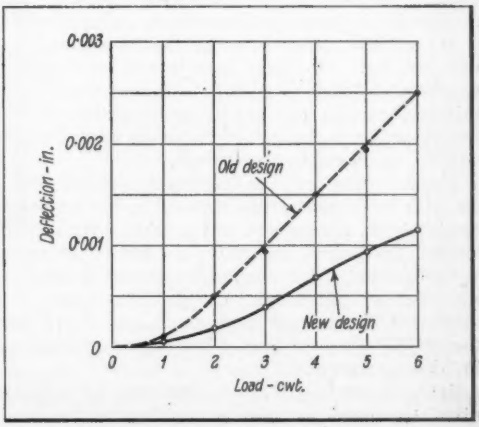

Fig. 9. Curves showing the vertical deflection of quills for conventional and improved-design tailstocks

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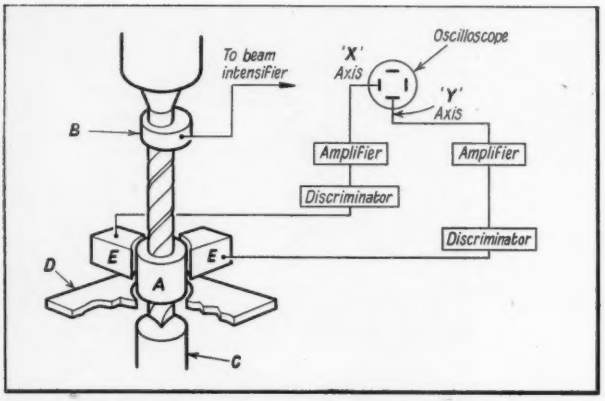


Fig. 10. Diagrammatic layout of an experimental set-up for measuring the radial deflection of a twist drill at the point of entry into the work

plain collar *A*, which is secured to the drill and rotates with it. An eccentric collar *B*, the purpose of which will be explained later, is also secured to the drill. The workpiece is seen at *C*, and immediately above it there is a sheet of insulating material *D* which has a hole large enough to pass the collar *A*, and to allow for a reasonable amount of radial movement. The sheet *D* serves to support two condenser units, as at *E*, which are arranged accurately at 90 deg. to each other and have arcuate surfaces at their inner ends, to match the periphery of the collar *A*.

The units *E* are connected electrically, by way of discriminators and amplifiers, to an oscilloscope, on which signals representing the deflections along the *x* and *y* axes are displayed. An indication of the lip position is given by the eccentric collar *B*, which is set with the high point of the lobe coincident with the lip. A signal from this collar is passed to a beam intensifier, once per revolution, and with this arrangement a record of the revolutions and of the lip positions is obtained, which is related to the deflections sensed by the units *E*.

Simple tests of the resultant deflections of machine tools under loads imposed by the actions of cutting tools, workpieces, and gearing, for example, are not applied as frequently as tests for accuracy and alignment. However, such tests are an obvious extension of the usual "no load" accuracy and alignment checks and there can be no doubt that their wider use would be of benefit to machine tool builders and users.

Research workers in many countries have recognized the need for greater rigidity in the basic structures of machine tools, and an interesting example showing the effects on the rigidity of a column member of the positions of holding down bolts, and the number and disposition of strengthening ribs, is given in Fig. 11. Perspective and plan views of five different designs of columns are seen at the top in this figure, and the directions of two mutually perpendicular forces are indicated at *x* and *y* on the column *a*. This column is taken as a datum, and with the holding down bolts arranged as seen in the associated plan view the bending stiffnesses in the *x* and *y* directions, also the torsional stiffness, are shown at 100 per cent in the accompanying bar chart.

When the holding down bolts are re-arranged as shown in the plan view for the column *b*, it will be noted that the torsional stiffness is increased by approximately 25 per cent, and the stiffness in the *y* direction by about 10 per cent. For the remaining designs of columns, the arrangement of the holding down bolts is approximately the same as for *b*, but one, two, and three strengthening ribs are progressively incorporated, at each side of the casting. With the design at *e*, it will be noted that the stiffness in the *x* and *y* directions has been increased by approximately 40 per cent, and the torsional stiffness by more than 50 per cent, as compared with the values for the original design at *a*.

Investigations have also been carried out into the reduction of torsional stiffness of cast beam members resulting from the inclusion of cored holes and apertures, as are commonly required, for example, to facilitate moulding, also for assembly purposes. It has been found that torsional rigidity may be reduced by as much as 83 per cent when two similar cored apertures are included in identical positions in opposite walls of a box-section beam.

Increasing attention is being directed to the use of welded steel structures for machine tool frames, in place of the iron castings conventionally employed. With suitable welded designs, the higher modulus of elasticity of steel results in structures possessing greater stiffness, higher natural frequencies, and improved damping characteristics as compared with conventional iron castings. As a result of developments in slideway materials, also lubricants, there is now little difficulty in providing welded members with satisfactory guiding and sliding surfaces, and modern techniques have made fabrication economically competitive with casting.

SPINDLE BEARINGS

The principal requirements for a machine tool spindle are: smooth and accurate rotation; adequate rigidity; small temperature rise; and good resistance to wear. It is interesting to note that between the years 1800 and 1900, when carbon steel tools only were available, cutting speeds rose from about 30 to 60 ft. per min., whereas from 1900 to the present time they have risen to 1,000 ft. per min. The latter figure is associated with ceramic tools, and research and developments in the field of cutting materials as a whole suggests that the trend towards higher cutting speeds is likely to continue. It may be necessary to design spindle assemblies which are capable of running continuously at speeds within the range 5,000 to 10,000 r.p.m., if full advantage is to be taken of developments in tool materials and metal cutting processes.

Research has been carried out in connection with various types of anti-friction bearings, from many standpoints, including radial and axial accuracy, also temperature rise under working conditions. Recent developments in the design and manufacture of plain bearings have resulted in a re-examination of the possibilities of this type of bearing for machine tool spindles. Methods of producing accurate internal profiles have led to increasing use of so-called multi-film bearings, in which the journal is supported on three or more separate hydro-dynamic films, equally spaced around the bearing. Advantages claimed for these bearings include improved journal location, greater stability against oil-film whirl, improved oil flow, and reduced clearances (of the order of 0·0002 to 0·0004 in.) as compared with conventional plain bearings.

Multi-film bearings have been applied to the wheel- and work-spindles of grinding machines, also to the headstock spindle of a turret lathe with a speed range from 315 to 2,800 r.p.m. With the use of a lubricating oil of high-viscosity, smooth rotation and accurate spindle location can be obtained at speeds, as low as 10 r.p.m., as are often required for the work-head of a grinding machine. A type of plain bearing in which the journal is located in the bearing by a relatively thick film of oil, supplied under pressure from a pump, is shown in Fig. 12. The load carrying capacity of this type of bearing is independent of the rotational speed, also the viscosity of the oil, and a powerful centralizing effect is provided by the throttling of the outlet ports on the loaded side.

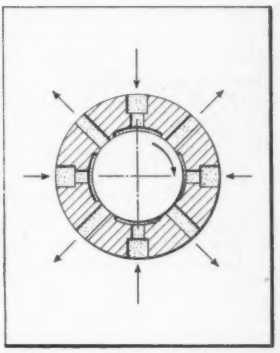


Fig. 12. In this hydrostatic spindle bearing there is a relatively thick film of oil, which is delivered under pressure from a pump. The throttling effect which is obtained at the bearing ends of the outlet ports has a powerful centralizing action

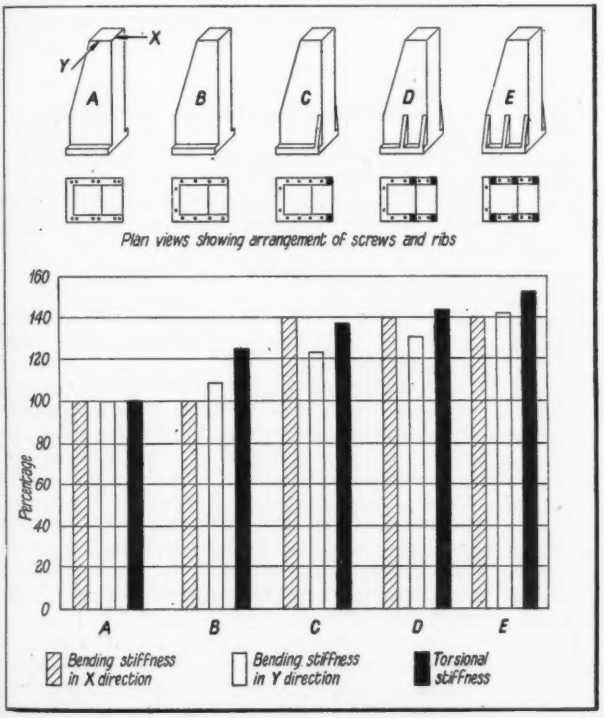


Fig. 11. The bar chart shows the increases in bending and torsional stiffness of machine columns which can be obtained with different arrangements of holding-down bolts and strengthening ribs

Air bearings, fed from an external pressure source, can be run at extremely high speeds and have been employed for the spindles of internal grinding machines. The rigidity and load-carrying capacity of an air bearing are low, in comparison with those of an oil-pressurized bearing, and its use is therefore restricted to a narrower field.

It may be noted that the results of tests carried out on a wide range of machine tools indicate that improved methods of cooling and heat dissipation for bearings will be necessary if the fundamental alignments of machines are to be maintained at spindle speeds which are substantially higher than those in use at present. Tests in connection with milling machines and grinding machines show that changes in the temperatures of bearings may extend over several hours, and that during this period substantial variations may occur in the machine alignments, and critical dimensions affecting the accuracy to which the work is machined.

If spindle speeds are to be raised substantially in the future, it appears that recourse may be necessary to such measures as forced cooling, by water circulation around bearings, in order to preserve thermal equilibrium.

CONCLUSIONS

Metal cutting is an extremely wasteful process, and expensive plant is employed to produce components which, on average, weigh only about 60 per cent as much as the original material. The remaining 40 per cent of the material is converted into swarf, in which condition it is worth approximately 10 per cent as much as in its initial form. Despite this inefficiency, however, and the rapid growth of other, more efficient metal-forming processes, such as extrusion and precision forging, the machine tool "population" of Britain is still greater than 1 million machines. The significance of machine tools in the development of this country, and in its ability to compete as an industrial nation, is such that every effort should be made to achieve the highest standards of design, construction, and utilization.

These ends can only be achieved by the closest possible co-operation between machine tool builders and users, assisted wherever necessary by scientific research establishments equipped to solve the fundamental and practical problems which at present determine the limits of metal-cutting practice.

ACKNOWLEDGEMENTS

Most of the material presented in the lecture has been taken from the research and development projects of P.E.R.A., and the author is pleased to have the opportunity of thanking the Association for permission to use this material,* and his colleagues at P.E.R.A., concerned with machine tool research programmes, for their assistance, particularly Mr. F. A. Lewis. In addition, he would like to express his appreciation of the co-operation he has received, especially in recent years, from many colleagues in machine tool research establishments abroad, including Professor Milton Shaw and Dr. Merchant, in the U.S.A., Professor Opitz and Professor Pahlitzsch in Germany, and Professor Zorev and Dr. Zuganov in the U.S.S.R.

Finally, the author welcomes the opportunity to thank the leaders of the machine tool industry of Britain for their continued support and co-operation in the research and development projects with which he has been concerned since he left that industry 20 years ago.

* This article presents only a brief abstract of Dr. Galloway's complete lecture, and for reasons of space a number of aspects have been omitted entirely. The lecture covered a very wide range of topics, dealing with most phases of machine tool design, research, and utilization, and in many instances Dr. Galloway was able only to give representative examples of the work and results which had been achieved. In almost every case, however, the source in which the fully detailed results were published is quoted in an appendix.—Ed.

Doulton Compressed Air Filter

The type F. 101 air filter, which has been introduced by Doulton Industrial Porcelains, Limited, Wilnecote, Tamworth, Staffs., a subsidiary of the Royal Doulton Potteries Group, is designed for a maximum working pressure of 250 lb. per sq. in., and has a capacity of 30 cu. ft. per min, free air delivery, at 125 lb. per sq. in. system pressure. It is claimed that in addition to pipe scale and other solids, it will effectively remove oil and moisture from the air.

An all-metal casing of aluminium alloy is provided, and a deflector on the inlet port imparts an initial rotatory movement to the incoming air, which then passes through channels and passageways at the lower end of a conical baffle of special design. At this stage, the majority of the impurities are removed, the air being directed with a spiral spin against the inside wall of the casing. Part of the air is caused to fan outwards to form a cone and in this manner carry-over of re-entrainment is prevented.

For final cleaning the air is passed through a porous ceramic filter element, which is made by a special technique to ensure high efficiency with relatively low pressure loss. Two types of filter are available, namely a standard 30 micron grade which is considered to be adequate for all normal purposes, and a 5 micron grade to meet particularly stringent requirements.

DIE CASTING SUPPLEMENT

Die Casting Operations at the New Factory of Thomas Ashworth & Co., Ltd., Burnley

By R. E. GREEN, Associate Editor

THE FIRM OF THOMAS ASHWORTH & CO., LTD., was established in Burnley in 1828, as an iron foundry, and the main product for many years was decorative iron railings. After the first world war, sand casting of aluminium alloys was introduced, followed by gravity die casting of aluminium, and during the last war the company made many millions of castings for such equipment as tank periscopes, bomb sights, and aiming predictors.

Other products of the firm, introduced comparatively recently, include the "Speedy" moisture tester, of which some 20,000 have been sold, 70 per cent of them in export markets, including about 400 per year to the U.S.A. The instrument is widely used in foundries, for controlling the moisture content of sand, and it consists of a bell-shaped aluminium gravity die casting with a pressure gauge fitted inside the large end. Measured quantities of the material to be tested are placed inside the bell, and a standard amount of a mixture containing calcium carbide is placed in an end cap.

This cap is secured to the open small end of the bell, and when the materials are subsequently shaken up together, acetylene gas is generated, with a consequent pressure rise inside the bell, which is registered on the gauge. The latter is graduated in percentages of moisture, and a direct reading of moisture content is thus obtained in a very short time. The instrument is made in two sizes, and is sold in a polished oak case together with scales for weighing the material to be tested.

In addition, the company makes beams and rollers for the textile industry, in aluminium alloy, which incorporate drawn tubes and gravity castings, as will be explained, and are supplied to users in this country and abroad. The design, supply and fitting of complete heating and ventilating systems for buildings are also undertaken. Until about a year ago, the various products of the company were being made in three small factories in Burnley, which were concerned with gravity and pressure die castings in aluminium; pressure die castings in zinc and the moisture testing instruments; and textile equipment. All these factories were rapidly becoming too small for the increasing outputs required, and larger premises were therefore sought.

As reported in a short article in MACHINERY, 97/1436—21/12/60, the company has recently occupied a new factory at Sycamore Avenue, not far from the centre of Burnley. Of substantial construction, the building was erected about 50 years ago, and has extensions which are 10 years old. Apart from various offices and stores, the factory is all on one level, and it occupies a site of some 130,000 sq. ft., the actual floor area, including that of the space devoted to offices, being 90,000 sq. ft. This area is sufficiently large to house the entire organization and to provide for limited expansion in the future. The firm produces about 14,000 castings per day, of weights from a fraction of an ounce up to 50 lb., and the consumption of metal is about 16 tons per week. Some 228 people are employed in the works, of whom 55 are women, and two shifts are in operation, each of 10 to 11 hours duration, with overtime.

Originally constructed as a cotton mill, and closed down under the Government's reorganization scheme, the factory was among a number of similar buildings for which alternative uses were sought by the local council. When it was first proposed that the building should be used for die casting, consultations were held with various authorities, and one of the matters which received particular consideration was the anticipated noise level from the new activities. It was thought that there might be considerably more noise from the factory than formerly, and that it might disturb surrounding residents, especially during night shift working.

Before any decisions were made, advice was sought from the D.S.I.R., and an expert was sent who provided valuable information on noise-suppression techniques. The principal noise, apart from that of the main air compressor which is driven by an 80-h.p. motor and supplies some 300 cu. ft. of free air per min. at a pressure of

Fig. 1. This view inside the foundry at the new works of Thomas Ashworth & Co., Ltd., shows the row of cold-chamber die casting machines for aluminium alloys, with a Bühler machine of 400 tons capacity in the foreground

150 lb. per sq. in., would have been high-pitched whine of the foundry exhaust fans. These fans form part of a ventilating system designed by the combustion division of the company for the extraction of fumes through hoods above each holding furnace, and there are five, each of which removes some 6,000 cu. ft. of air per min., to provide for eight complete changes of air per hour, in the foundry.

These fans were silenced by means of special units, designed and made by the company, and fitted in the exhaust ducting, and the total noise from all five fans was thus reduced to less than that caused by a single fan in the unsilenced condition. The noise of the compressor was also reduced, by insulating the concrete block on which it rests from the surrounding building with felt strips. An upper floor in the main building, formerly used as the preparation warp sizing shop, has a maple floor. It was converted into a design and general office, and has a fire-resistant ceiling specially designed to prevent echoes, so that the noise level is very low.

This ceiling is made up of expanded metal, supported on T-section aluminium extrusions, with a layer of tissue paper supporting vermiculite particles which absorb noise. An oil-fired boiler installation provides a ducted supply of warmed and filtered air to the offices, and this air passes upwards to return above the ceiling, after which it is mixed with fresh air and recirculated.

DIE CASTING FOUNDRY

The latest extension to the factory, erected some 10 years ago, has dimensions of about 110 by 170 ft., and was selected for the foundry because it has a roof of steel construction, with sheet aluminium panels, so that the fire risk is almost negligible. Approximately half the area of this building is devoted to gravity die casting of aluminium and is separated from the pressure die casting section by a row of bulk-melting furnaces. It may here be noted that all the bulk-melting and holding furnaces are gas-fired, and that the consumption is more than 2·5 million cu. ft. of gas per month. The management is, however, seriously considering a change-over to oil-firing. Most of the furnaces are of the "Efficiency" or "Speedy" types, made by the company, and Morgan plumbago crucibles are employed, which are inspected monthly.

Parallel with the row of bulk-melting furnaces is a line of cold-chamber die casting machines, including two E.M.B. No. 12 units converted from hot-chamber designs, which have a die locking force of 35 tons and are capable of producing castings weighing up to 1 lb.; four Reed-Prentice (Alfred Herbert, Ltd.) machines—three of 250 and one of 150 tons locking force—for castings up to 3·5 lb.; and one Bühler machine of 400 tons capacity, for castings up to 8 lb. A view inside the foundry showing the row of cold-chamber machines, with the Bühler machine in the foreground, and the gravity casting section in the background to the right, is given in Fig. 1.

The larger machines in this installation are fitted with equipment whereby the complete die casting cycle is accurately controlled, electronic timing units being employed for determining the dwell periods, and are arranged for a 3-phase injection cycle. Gravity and pressure die castings are made in about ten different aluminium alloys from the

L.M. range, numbers 2, 4, 6, 8 and 16 being used most extensively, although several castings for food-processing equipment are made in L.M. 18 alloy, since this material has a copper content of less than 0·1 per cent.

A row of benches separates the cold-chamber machines from those employed for the hot-chamber casting of zinc alloys, which include three No. 215 Kippcasters for castings up to 6 oz.; two E.M.B. No. 12 machines for weights up to 4 lb.; and a single Schultz machine, of 350 tons locking force, for weights up to 10 lb. A view of this last machine is given in Fig. 2, and it is arranged for full electronic control of the casting cycle, as described in MACHINERY, 90/1232—31/5/57. All the castings produced meet the requirements of the B.S. Kite Mark scheme, samples being sent to a laboratory for analysis daily.

Each of the pressure die casting machines can be connected to a supply of cooling water which is returned to the storage tank along channels in the floor. Covered with metal gratings, these channels have rising pipes, fitted with funnels into which flexible tubes from a die are led. All the pressure die casting machines are coupled to a Centralograph (Telephone Rentals, Ltd.) system (MACHINERY, 95/142—29/7/59) and the code of numbers provides for the dialling of the following information:—1. Die setting. 2. Waiting for operator. 3. Waiting for metal. 4. Fault in die. 5. Mechanical fault in machine. 6. Electrical fault in machine. 7. Patrol inspector. 8. Die being repaired. 9. Maintenance department working on faults 5 or 6. At present, the cipher is not being used.

The installation is sufficiently large to provide for 20 machines or seven more than the present installation. It may be noted, however, that a further machine is on order and is due for early delivery.

RECORDING OF CASTING PROCEDURES

The efficient operation of die casting dies, and the effective application of all the detailed information relating to a particular die, which is obtained during the initial try-out stages, is facilitated by keeping records in the form of set-up cards, as shown in Fig. 3. These cards are filled in during the die-proving period, square spaces being provided in the lower half whereon sketches showing the positions of the cavities, runner bars, cores and overflows are drawn. Numbers on these sketches show the positions at which measurements of die temperature, with a surface pyrometer, are taken, when satisfactory operating conditions for the die have been determined empirically.

Provision is made for recording these temperatures alongside each sketch, so that when the die is again put into service, the flow rates of the cooling water through the die channels can be quickly set. A note in the space reserved for special operating instructions asks for emphasis to be placed on the defect which the specified procedure is designed to eliminate. This note ensures that the setter and the die operator know what faults to look for on the castings produced. On the back of the card, space is provided for recording any special instructions regarding inspection of the castings to which the card relates.

The cards are provided with punched holes for convenience in storage, and two duplicate copies of each are made. These duplicates are supplied to the time study and progress planning departments. Before a new die is cleared for production,

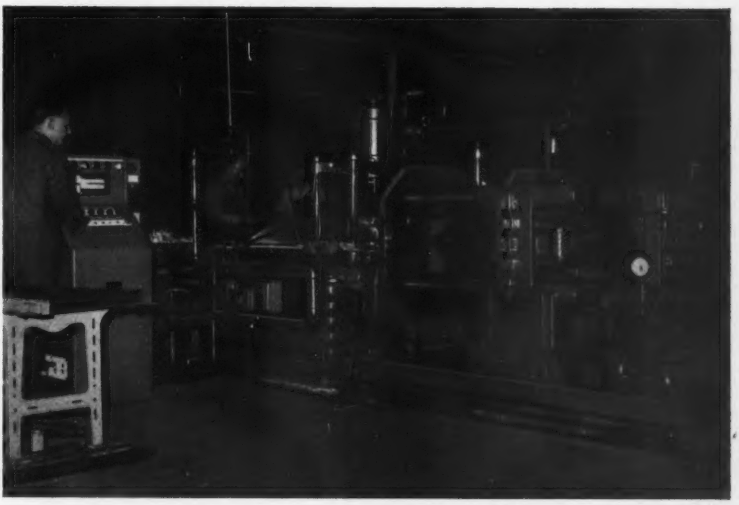


Fig. 2. Full control of the casting cycle by means of electronic timers and solenoid valves is provided on this Schultz GJ hot-chamber die casting machine, which has a die locking capacity of 350 tons

THOMAS ASHWORTH & Co., Ltd.

SET-UP CARD

DIECASTING DEPARTMENT

DATE ISSUED 22ND FEB. 1960.

Details of Die :—

DIE NUMBER: B N. 221

NUMBER OF IMPRESSIONS OR UNITS: 3

MACHINE TYPE: REED PRENTICE

PREHEAT TIME: 1½ HOURS

DIE TORCH LOCATION: SQUARE BURNER

PLUNGER OR PISTON DIAMETER: 1¾" DIA

LUBRICATE PLUNGER EVERY 4 SHOTS

Cores Pulled By	Castings Ejected By
Hand Pinion	Hand Pinion
~~Rock~~ ANGLE PIN	Bumper ✓
Hydraulic	Hydraulic

Details of Running :—

NUMBER OF MEN: ONE

TYPE OF GATE: SIDE ✓ CENTRE ✓ HI ✓ LO OFF

Pressure lbs./sq. in.: AIR / HYD. 1000

Machine Operation: HAND / AUTOMATIC ✓

DWELL, SECS. 23

Casting Placed In: TRUCK ✓ / CONVEYOR / QUENCH

Details of Alloy :—

ZINC ALUMINIUM

GRADE OF ALLOY: LM2 HI.

ALLOY TEMP. 650°C

Bar Alloy ✓ Hot Alloy

ALUM. ALLOY LADLED Hand ✓ Automatic

LADLE SIZE 5"

WEIGHT PER SHOT INCLUDING SPRUE AND INSERTS 2·281 LBS.

ALLOY WEIGHT OF ONE COMPONENT

Details of Component :—

COMPONENT NUMBER CX 3995 AX 3990 AX 4112

Modification letter must be shown

COMPONENT NAME RESILIENT MOUNTING HOUSING-PULLEY+INSERT

CUSTOMER BURCO LTD.

FINAL FINISH AS CAST

OPERATING CYCLE SECS. 85

AVERAGE NUMBER OF SHOTS PER HOUR 42·5

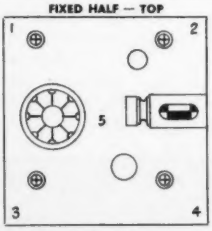
INSERTS NUMBER USED PER IMPRESSION

QTY.	PART NUMBER
	NONE

SPECIAL OPERATING INSTRUCTIONS (Emphasize defects to be avoided)

LUBRICATE ALL CORES TO AVOID PICK UP AND TEARING

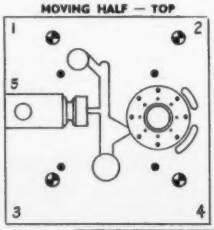
FIXED HALF — TOP



DIE TEMP. AND LOCATION

1. 175
2. 150
3. 175
4. 175
5. 180
6.
7.
8.

MOVING HALF — TOP



DIE TEMP. AND LOCATION

1. 120
2. 120
3. 100
4. 100
5. 120
6.
7.
8.

LUBRICATE DIE AS BELOW

A EVERY 1 SHOTS USING BRUSH ~~AIR HOSE~~ WITH DIE SLICK

B EVERY 1 SHOTS USING ~~BRUSH~~ AIR HOSE WITH WALKERS

C EVERY SHOTS USING BRUSH AIR HOSE WITH

D EVERY SHOTS USING BRUSH AIR HOSE WITH

SHOW GATES AND OVERFLOWS IN BLUE — WATER LINES WITH DOUBLE LINE RED. USE ARROWS FOR DIRECTION OF WATER FLOW, AMOUNT BY FILLING IN DOUBLE LINE PARTIALLY OR SOLID, DOTTED FOR STEAM; INTERCONNECTED BY DASHES. HEATING DEVICES IN GREEN.

SIGNATURES OF :

TRY-OUT MAN .....

FOREMAN .....

METHODS .....

INSPECTION .....

Fig. 3. Details of the optimum operating conditions for each die, obtained during the try-out stages, are entered on set-up cards. The information recorded includes temperature readings at different positions on the die face

signatures of the die try-out man, the foreman, the method study man, and the inspector who have co-operated in the work must all be obtained on the card. It may be noted that methods of payment by results are employed in the works.

Most of the dies are made in the company's toolroom, which is well-equipped and provides employment for 26 toolmakers. Machine tools include lathes to swing diameters from 7 to 48 in., and a number of milling machines, one of which is equipped for hydraulic copying work. One of the latest milling machines to be installed is the Huron (Rudolph Carne & Co., Ltd.) universal type shown in Fig. 4, which was selected because of its capacity for work up to 70 in. long by 27 in. square. The machine is shown set up for rough milling a cavity in a die block for a control box casting of tapered form, measuring approximately 6 in. by 4 in. by 4 in. deep. For this operation, a 1-in. diameter, long-series, 6-bladed cutter, is run at 250 r.p.m., with a feed of 6 in. per min.

During recent years, the company has been investigating several of the newer methods of die making which have been developed, with a view to adopting the most effective. Among the methods which have been tried may be mentioned various precision casting techniques, and electro-erosion or spark-machining, and die blocks have been sent to specialist companies, to enable the results produced by these different methods to be assessed. The die block on the Huron machine, for instance, is to be sent to the French firm, La Soudure Electrique Languepin, 20-28 rue Toulouse-Lautrec, Paris 17e, who maintain a sub-contract spark-erosion department mainly for prospective buyers of their machines.

An example from the range of spark-erosion machines made by this company, under the name of Seleromat, was described in MACHINERY, 93/1355—10/12/58, in connection with the Mécanélec Exhibition in Paris, and the machines

are now being made under licence in this country by Solar Weld Languepin, Ltd., Fulledge Works, Burnley. In making electrodes for spark-machining a cavity of the shape of the aluminium master seen at *A* in the close-up view of the Huron machine in Fig. 5, the first step is to duplicate this item. This duplication is carried out by making a plaster mould which is then sprayed internally with copper to a depth of about $\frac{3}{16}$ in. all over.

Next, the copper lined cavity is filled with molten zinc, or some other low melting-point alloy, and a mounting arbor is positioned in the flat upper surface before the alloy solidifies. With the plaster removed, the resulting copper-faced electrode is ready for the spark-machining operation, on a Seleromat machine. For the shape represented by the master form, the die block is machined to produce a cavity with about ⅛ in. of material left on all surfaces, no attempt being made to achieve accuracy of form. This preliminary work is carried out merely to speed up the die-sinking process and reduce the number of electrodes required. The die is made from KE A145, 5½ per cent chromium-vanadium-molybdenum steel, supplied by Kayser Ellison & Co., Ltd., Sheffield, this steel being used almost exclusively by the company for pressure dies. Heat treatment of the steel is carried out by the Kayser Ellison company.

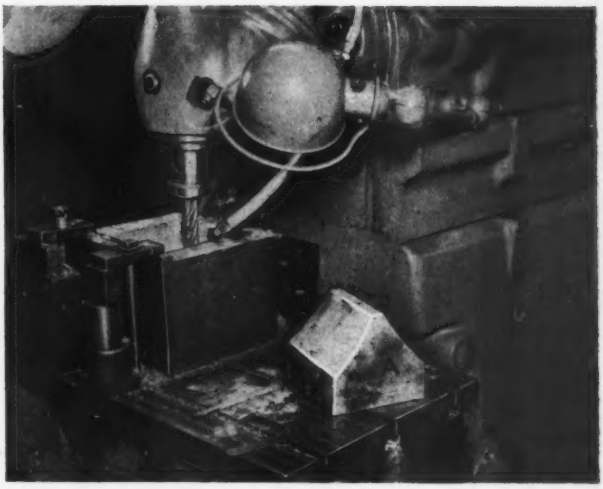


Fig. 5. Close-up view of the Huron machine, showing the die block for a control box casting die, in which the 6- by 4- by 4-in. cavity was rough-machined prior to spark-erosion

Fig. 4. Among the latest equipment to be installed in the toolroom is this Huron universal milling machine, which has a capacity for workpieces up to 70 in. long by 27 in. square

DIE FOR LAMP MOUNTING BRACKET

Both halves of the die for an adjustable lamp mounting bracket, shown after the completion of proving trials and heat treatment in Fig. 6, have cavities of similar form but of opposite hand. The casting from this die, seen at *B*, is of L.M. 2 alloy, and is about 7½ in. long by ¾ in. wide by ½ in. thick at the centre. Of symmetrical form, the casting has compound curves on both sides, and the machining of the die cavities by conventional methods would have been extremely difficult. For this reason, the die was produced by the Languepin company, who used five electrodes of the type shown, which are solid precision castings in copper, to sink the two cavities from

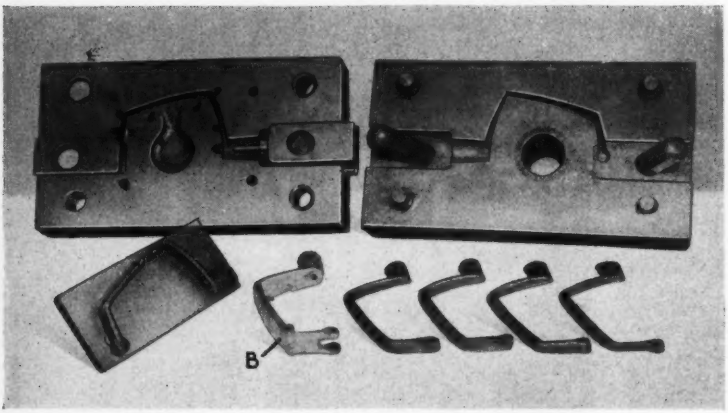


Fig. 6. Cavities in both halves of this die for pressure casting the adjustable lamp mounting bracket *B*, were machined from the solid by spark erosion, using five cast copper electrodes of the form shown

the solid. No machining of the cavities was carried out prior to spark-erosion, but the runner channels and core cavities were machined afterwards.

Each cavity was completed in about 11 hours, and during the process considerable erosion of the electrodes, which were all of the same size originally occurred. The effects of this erosion were largely nullified by the use of a succession of electrodes, so that very little metal was left for removal at the final stage. Since the requirements as regards this casting were for symmetry rather than accuracy, small discrepancies in shape could be disregarded, but it has been found that spark erosion will produce cavities sufficiently accurate for die casting other parts if a sufficient number of electrodes of the required precision is provided.

SPARK-ERODED IMPELLER DIE

Another die which was recently produced by spark erosion, provides for pressure casting an impeller, in L.M. 2 material, and is shown in Fig. 7. The impeller, indicated at *C*, has a diameter of 6 in., and there are six straight blades, each 1½ in. high, which vary in thickness from ⅛ in. at the top to about $\frac{3}{16}$ in. where they join the disc. The spark erosion work on this die was carried out by the French firm of Qualitex-Dunod & Cie., 94 rue de Paris, Clichy (Seine), who are represented in this country by Dorman Machinery Sales, Ltd. The machine employed was a Usimu C2 ter, of 6½-kW. capacity, as demonstrated at the 6th European Machine Tool Exhibition (MACHINERY, 95/448—9/9/59).

For this die, the electrodes were in the form of thin copper plates, with tapped holes in their thicker edges, for attachment to a copper disc, by screws. Each plate had two copper "swells" fastened to one side to form the projections against which the ejector pins bear. Four electrodes of this type were required, and when they had been prepared, the work of erosion was carried out in only 24 hours. As will be evident from the form

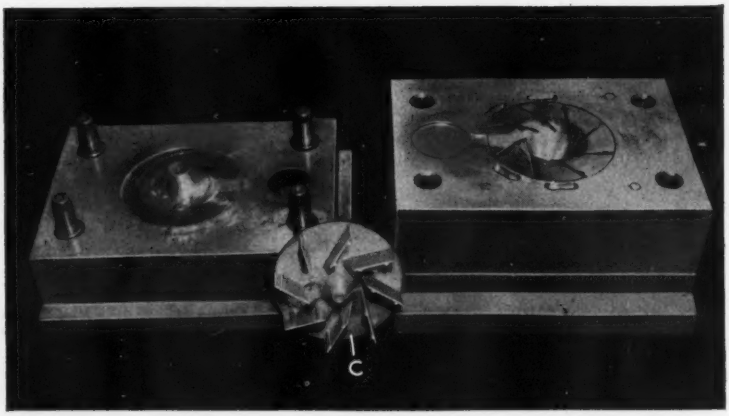


Fig. 7. Electrodes for spark erosion of the cavities in this die for an impeller, with a disc diameter of 6 in., were made from copper. The separate blades were attached to a plate by means of screws

Fig. 8. This die, for gravity casting food mixer screws, two at a time, was cast in high-duty iron by the Shaw precision process. Machining of the cavities would have presented considerable difficulty

of the fixed half of the die, the rear face of the casting disc has a hollow centre, and there is a scroll projection on the surface with an average height of 0·030 in., and about ⅛ in. wide. The cavity in which this projection is formed was also produced by spark erosion.

PRECISION-CAST GRAVITY DIE

Most of the gravity dies employed in the works are of high duty or nickel-molybdenum acicular cast iron, depending on the type of casting to be made, and as a rule they are produced by conventional machining methods. The die shown in Fig. 8, however, for the production of feed screws for a mincer in L.M. 18 low copper alloy, was made by the Shaw process by Precision Products, Ltd., Alston, Cumberland, examples of whose work were described in MACHINERY, 87/582—2/9/55, and it incorporates two cavities which are arranged vertically, side-by-side.

Owing to the form of the screws, with their tapered edges and variations in pitch from one end to the other, and to the fact that it was desired to produce a 2-cavity die for economic reasons, machining would have been extremely difficult. The production of a master, from which the necessary Shaw-process die could be made, was very much easier. Each casting is about 4 in. long, by 1¾ in. diameter, and is provided with a substantial over-run at the lower end. These over-runs are so designed that pressure can be applied to them by means of two ½-in. diameter horizontal ejector pins, advanced by means of the lever *D*, after the die has been opened. At the same time, the operator grips the spray with tongs on a parallel-sided rib, provided on the central runner bar for the purpose, to ease the castings out of the cavities.

For the gravity dies used in the foundry, the clamps take the form of hinged levers, each of which is pivoted on a large-diameter pin on one portion of the die, the other die member frequently being fixed to the bench for convenience in operation. Each lever has an enlarged flat head with a curved slot which engages with a pin of about the same diameter as the slot width, on the

Fig. 9. A ring-shaped aluminium component is cast in this die, which is provided with two cam-slot type clamps. Cam surfaces on these clamps serve both for locking the die and for opening it when the casting has solidified

side of the fixed die member. As the lever is pivoted, the die halves are brought together by the cam action between one side of the slot and the pin, and are finally locked in position. After the casting has solidified, the lever is returned to its original position, and during this movement the opposite side of the slot acts against the pin, with the result that the die lock, and the shrinkage grip of the casting on any cores, are broken, and the die is opened by about ½ to 1 in., without the use of hammer or lever.

Clamps of this type are provided for the die in Fig. 9, for gravity casting a ring-shaped aluminium component. One member of the die, at the right, is carried in a bracket on the base-plate which forms the top of the supporting bench. This fixed member has a single clamping pin at the near side, and a pivoted locking lever clamp, of the type described above, at the far side. The moving member of the die, nearer to the camera in Fig. 9, has the opposite arrangement, the clamping lever being indicated at *E*. From the pouring opening at the top of the die, the metal enters the annular cavity through evenly-spaced gates round the periphery.

When solidification is complete, the levers are raised to a vertical position, and the die is opened slightly. The moving member can then be swung round, on the vertical post at the far side on which it is pivoted, until the ejector pins protruding from the outer face strike against other, adjustable, pins on the fixed plate at the left. The ejector pins are thus advanced, to expel the casting from the die.

Other gravity and pressure die casting dies, also the trimming arrangements, employed in the factory will be described in a further article to be published shortly.

Detroit Die Casting Congress

Summaries of Some Additional Papers

In MACHINERY, 97/1475—28/12/60, summaries were given of several of the papers presented at the recent Detroit Die Casting Congress. Among other papers of particular interest was one by Sr. G. Triulzi, president of A. Triulzi S.A.S., of Milan, who described the equipment which is being produced by his company for shipment to Russia, where it will be used to produce cylinder blocks for the Volga passenger car.

He spoke of the pioneering work on the development of the die cast engine block carried out by the Doehler-Jarvis organization in the U.S.A., and said that, although in Europe no die cast block was yet in production, many European automobile companies realized its inevitability. Some companies were already producing blocks by permanent mould casting. This enabled modifications to the basic design to be made quite cheaply and improved engine designs would result.

From the thermodynamic viewpoint, aluminium was a very suitable material, and production of blocks by die casting for the European market (with its preponderance of 4-cylinder engines) presented the designer with few new problems. On the production side, aluminium was preferred to grey iron because it enabled higher machining speeds to be employed.

The first production engine block to be pressure die cast in aluminium would be that for the Russian Volga saloon. This engine would be a 4-cylinder type of 2·5 litres capacity and would be water-cooled. The liners would be inserted after casting. The machine on which the block would be die cast was the most powerful so far built anywhere in the world, with a locking force of 2,500 long tons. It incorporated automatic ladling, by a system already well tested by the Triulzi company, and would also be fitted with electro-hydraulic equipment for unloading the casting from the die and transferring it to the machining line.

In operation, it would only be necessary to press the starting button, and thereafter all the phases of the cycle would proceed automatically. The sequence would be: (*a*) die closure; (*b*) transfer of a metered quantity of molten aluminium to the shot-sleeve; (*c*) injection; (*d*) opening of the die; (*e*) withdrawal of cores by hydraulic cylinders; (*f*) ejection of the casting; (*g*) withdrawal of the casting from the die; and (*h*) delivery of the casting to a conveyor on which it would be carried to the trimming press.

The equipment for the 4-cylinder block was now nearing completion, and sample castings would soon be available for evaluation. It was interesting to note, moreover, that studies for the production of a die-cast block for an 8-cylinder engine were already being undertaken. For this block it had proved necessary to depart in several respects from conventional design, in order to meet the requirements of the die casting process, but the automobile engineers had accepted the neces-

sity for such modifications. The successful production of units of this type would further increase the scope of die casting as a means of producing engine parts, for the industry would be able to look beyond the field of passenger cars—for example, to the manufacture of tractor engines. In the U.S.S.R., some structural aluminium die castings for tractors were already being made, with weights up to 35 lb.

DEVELOPMENTS IN AUTOMATION

A paper entitled "Automation in Die Casting" was presented by L. S. Garretson and T. E. Nadeau (Hardware and Accessories Division, Ford Motor Co.). The authors stated that complete automation of the die casting process was by no means a novelty. For many years manufacturers of toys, jewellery, electrical fittings and motor vehicle accessories had employed automatic die casting machines for the production of small parts in zinc and low melting point alloys. What was new was the extension of automation, firstly, to very much larger machines, and, secondly, to the higher melting point alloys of aluminium and magnesium. The advantages of automation in this wider field lay primarily in the higher production rates that could be achieved. As an example, a 400-ton machine, producing a part which could be cast at the rate of 100 shots per hour under manual control, had proved capable of operating automatically at 300 shots per hour. To achieve such results, close attention had to be paid to temperature control, and the various phases of the cycle had to be timed with great care. The reward was fewer rejections, higher production, and a reduction of down-time.

Conversion of a machine to automatic operation was neither a complex nor a costly matter, but it did entail a full appreciation of the many factors into which the die casting cycle must be broken down if the need for an operator was to be avoided. Die casting involved six basic operations, and there were five process variables that had to be brought under control. The operations were: (*a*) die cleaning and lubrication; (*b*) die closure; (*c*) plunger lubrication; (*d*) metal transfer and injection; (*e*) die opening; and (*f*) casting ejection and removal. The process variables were: (*a*) metal temperature; (*b*) die temperatures; (*c*) volume of metal transferred; (*d*) injection speed; and (*e*) injection velocity.

As regards die cleaning and lubrication, this was such an elaborate operation when carried out manually that no attempt should be made at imitation by means of an automatically actuated device. By careful consideration of part design and die design, however, it was possible to establish simpler automatic procedures that would be quite effective in practice. As automatic lubrication entailed the release of a small quantity of the lubricant at each cycle, homogeneous materials were to be preferred in order to avoid both settling out and the possible obstruction of spray nozzles. If pigmented lubricants were used, it might be necessary to keep them circulating through the delivery lines continuously to prevent sedimentation.

Die closure on an automatic machine required no special provisions except a sensing device to ensure that the die halves would not close on an obstruction. The usual sequencing controls and interlocks on die movements and guards, to prevent the completion of the cycle if any step had been omitted or imperfectly performed, were still required. The absence of visual inspection of the die—to check, for example, that a casting was not still "hung up" on the ejector pins—might make it necessary to add additional guards and safety devices.

Automatic plunger lubrication was already used fairly extensively even on manually-operated machines, a measured quantity of lubricant being forced at each shot into the clearance between plunger and shot-sleeve. Both low and high pressure systems were used successfully on cold-chamber machines arranged for automatic operation. On hot-chamber machines, of course, this particular problem did not arise, and the same applied to problems of metal transfer. Automatic metal transfer for cold-chamber machines could be accomplished by a variety of methods, for example, by mechanical dippers, positive air pressure, negative air pressure, ceramic piston pumps, and gravity feed. The attention of aluminium die casters was now, however, focused upon vacuum fill as the preferred method of metal transfer, and with some systems, the additional advantage was offered that the die cavities were evacuated. Vacuum fill also effectively prevented the entry of dross into the shot sleeve.

On both manually and automatically controlled machines the solidification period prior to die opening must be carefully timed, so that no new problem arose in this respect. As regards ejection, the mechanics remained the same as for manually controlled machines, but positive means had to be employed to ensure removal of the casting from the ejector pins. The simplest method of removal was to drop the entire spray of castings on to a fixed chute below the die opening. Zinc alloy die castings were frequently dropped into water to cool and strengthen them for immediate mechanical handling. If improved handling methods were required on account of size, weight, or finish, special mechanical arrangements, or a conveyor, or both, might be needed.

Metal temperature must be controlled more closely when a machine is automatically operated, and the temperature at which it is maintained may well differ from that required for manual operation, due to the higher production rate. Particular attention should be paid to periodic fluctuation due to replenishment of the metal supply, and the entire system of metal feeding might have to be changed in order to ensure the minimum of temperature variation.

Die temperatures, on the other hand, necessarily fluctuated widely during each cycle, so that control was directed toward ensuring that the pattern of fluctuation was repeated without change at each cycle. Monitoring of temperature and pressure of the water supply was essential in the absence of operator scrutiny. Cooling water needed to be treated to eliminate corrosion problems, which could greatly alter the heat transfer achieved. For these reasons, a closed-circulation cooling system was called for.

Another approach to die cooling was "low-gradient" heat transfer, which, again, required closed-circulation cooling. When the die was in operation, heat passed to the coolant and was removed at another part of the circuit. If the operation of the die was interrupted, the coolant temperature fell. When a predetermined drop had been exceeded, the system began to heat the coolant, and the fall in the temperature of the die was arrested. Because the coolant operated at a much higher temperature than water, larger channels and a higher recirculation rate were necessary. Low-gradient cooling possessed many operational advantages and was easily applied to fully-automatic machines, but the cost was high.

The control of metal volume transferred at each shot was necessary on cold-chamber machines only. With vacuum fill, volume control was achieved by timing the application of vacuum to the supply tube. Such a control was sensitive to the height of metal in the holding furnace and to the intensity of vacuum applied, but compensation could be made for both. With systems incorporating ceramic pumps, standard transfer volume was easily maintained, and it was only necessary to provide timing and sequence controls which operated during the machine cycle. Where transfer was effected by positive air pressure upon the surface of the metal, compensation for change of level was made automatically. Mechanical dippers, which simulated hand-ladling, could also be designed so that they were unaffected by normal fluctuations in metal level. The gravity feed system, developed for use with magnesium alloys, again relied on a timing device to control the volume of metal fed into the shot sleeve, but was not affected by metal level changes.

Injection speed was a highly critical factor, and whether a high or low speed was used, exact duplication of the plunger velocity at each shot was essential for consistent production. Automatic plunger lubrication, uniform hydraulic pressure, and uniform restriction at the valve, contributed toward the maintenance of uniform velocity, but there could still be a drift in velocity (due to changes in oil temperature and other variables) which was difficult to monitor. Here, new control methods were required. In particular, there was a need for some kind of precision interval timer capable of indicating plunger velocity at a selected point in the stroke. Such a timer would be of value, both for initial setting up and in subsequent "trouble shooting," should there be a decline in casting quality.

Injection pressure, as defined by the authors, referred specifically to the pressure actually applied to the fluid metal just prior to solidification. By controlling it, cavities could be filled without excessive flash formation. Control could, however, only be indirect, and depended upon correct choice of intensifier pressure, pump pressure, and plunger area. The available control measures have been found to suffice for fully automatic operation.

Increased automation did not necessarily result in reduced employment for skilled operators, since if it were applied during a period of growth in demand, the operator might: (*a*) attend and supervise three or four machines operating automatically; (*b*) advance to the position of set-up man and in-process inspector; (*c*) expand his activities to include trimming the castings while supervising the operation of the machine; or (*d*) merely transfer to

COST COMPARISON FOR MANUAL AND AUTOMATIC CASTING

Cost Factor	Single-cavity Manual	Single-cavity Auto	Two-cavity Manual	Two-cavity Auto
Machine	100 tons	100 tons	200 tons	200 tons
Shots/hour	280	370	230	300
Nett pieces/hour	250	350	390	570
Direct labour:				
(*a*) Men/shift	1	½	1	½
(*b*) Man/min./piece	0·2400	0·0430	0·1540	0·0351
(*c*) Dollars/piece	0·0120	0·0022	0·0077	0·0018
Overhead, per cent	400	1,150	450	1,300
Dollar cost	0·0600	0·0275	0·0424	0·0252
Metal cost, dollars/piece	0·0600	0·0600	0·0600	0·0600
Total pieces	1,320,000			
Total cost, dollars	158,400	115,500	135,300	112,500
Tool cost, „	6,000	6,000	9,000	9,000
Final cost, „	164,400	121,500	144,300	121,500

another die casting operation that did not lend itself to automation. The authors did not foresee the general displacement of die casting machine operators by automatic die casting. As rapidly as automation could be applied to large and difficult die castings, still larger and more difficult castings would be brought within the ambit of the process, and skilled operators would be needed in the industry for many years to come.

One could draw up a rough table of the assets and liabilities of automation, something as follows:—

Assets	Liabilities
1. Increased casting rate.	1. Increased supervision, more critical control.
2. Reduced scrap rate.	2. Increased inspection of castings.
3. No operator.	3. Fewer shots per die set-up.
4. Lower die cost.*	4. Higher die cost.*
5. Maximum safety.	5. Longer setting-up time.
6. Longer die life.	6. Larger investment in equipment and controls.

The decision to employ complete automation ultimately depended upon the net cost of producing the part, as a specific example might best serve to show. This example related to an enquiry for a zinc alloy die casting for which the estimate was to be based on an output of 6,000 pieces per day, and was to run for 20 days per month for 11 months. The part was similar to others that had been successfully produced automatically in the past, was to be trimmed but not machined, and had a trimmed weight of 8 oz. The first requirement was to establish the most economical method of producing the part, and this entailed making parallel estimates for the competing alternatives. This particular part could be cast in either a single-or a 2-cavity die, so that the analysis was as shown in the table.

The comparison showed that the two automatic methods would give the same result, and that the single-cavity manually-operated method would be the most costly. It should be noted, however, that the analysis relied heavily upon the accuracy of the overhead rate for direct labour, and the technique required the elaboration of a great variety of overhead rates to match the different ways in which direct labour might be changed to an automatic machine. The costs thus established might, or might not, be used as a basis for quoting. Normally, the price quoted would be influenced by past experience and current market conditions.

* Die cost may be higher or lower, depending upon many considerations at the die-planning stage.

ESTABLISHING DIE CASTING COSTS

Mr. U. F. von Rosen, a Cleveland accountant, described in his paper, "A Case Study in Establishing Die Casting Costs," the methods employed by his firm in developing cost standards for a U.S. die casting company. All expenses were analyzed to determine their fixed and variable elements, that is, those that remained constant whatever the level of production, and those that fluctuated with output. This analysis was absolutely essential if the true cost of production for an output level differing from that existing at the time of the study was to be established. In addition, expenses were divided into those that could be set off completely against some specific department, and those for which a basis of apportionment between different departments needed to be worked out.

The apportionment of expenses was facilitated in three ways. Firstly, the allocation of the supervisory pay-roll, as well as the basis of distributing costs for various service departments, was largely determined at a meeting of the foremen and the supervisory staff. Secondly, an up-to-the-minute floor plan of the buildings was made and the boundaries of the various departments, as agreed, were marked on it. Thirdly, a valuation and inventory had recently been made by an outside appraiser, which grouped the machines by departments and showed the replacement cost and current value of each. It also showed the rated horsepower of the motors, adjusted by a load factor, and these figures were multiplied by the estimated annual hours of operation, converted into kilowatt-hours, and used as a basis for allocating power costs to all departments.

The final step was the establishment of standard rates per machine hour and per direct labour hour in all but one of the departments. The exception was the plating shop, where rates were expressed as so much per rack. This method was adopted because, with the automatic system used by the company, the racks moved at a constant speed through the plating sequence. The rates in all other production departments were arrived at by taking the total of expenses originating with, or benefiting, the workers concerned, and dividing by the total normal machine hours.

The procedure described produced a rate that absorbed the total of departmental overheads at normal (100 per cent) production. At the request of the management, the author also determined rates that would absorb the entire overheads at production levels 25 per cent above and below normal.

Fellows 4BGF Gear Finishing Machine

Brief reference was made in MACHINERY, 97/956—26/10/60, to the newly-introduced Fellows (Alfred Herbert, Ltd., Coventry) type 4BGF gear finishing machine, shown for the first time at the recent Chicago Machine Tool Exposition. A general view of this machine is given in Fig. 1, and it is designed for operations on gears of 0·5 to 4 in. pitch diameter, up to 6 d.p., and 2·25-in face width. Three types of machine are made—for gears with parallel-sided teeth; for similar gears but with provision for the later addition of equipment for crowning if required; and for crowned gears. These machines are designated 4BGF-NC, -AC, and -C, respectively.

The machine is equipped with a special cutter of the Fellows type, in the form of a gear with involute teeth which taper from the cutting face at an angle of 7 min. to provide relief. With this small angle, it is ensured that sharpening of the cutter, which can be performed on a surface grinder by taking a light cut over the face, does not affect the accuracy of the finished gears. Gears up to 1 in. face width can be crowned to the extent of 0·0004 to 0·0005 in. with the standard clearance-angle cutter. Increased crowning, up to 0·001 in., can be obtained with a cutter having a clearance angle of 14 min.

As seen in the close-up view in Fig. 2, which shows the inside of the cabinet surrounding the working area, the cutter is mounted in a crossed-axis relationship with the gear to be finished. Here, the magazine of the automatic loading and unloading mechanism, fitted to the demonstration machine, has been swung aside to the right to show the work gear, on the nearer spindle at the left, and the larger cutter on the rear spindle. The angular relationship between the work gear and the cutter, in terms of their respective numbers of teeth, is controlled by very accurate, hardened and ground gears in the work-spindle assembly, and the helix angle is governed by a helical guide.

The work-slide is actuated hydraulically, for feeding the gear past the cutter, the rate of feed being adjusted by a flow valve. In operation, the work is loaded on to the expanding arbor of the work-spindle, either by hand, or, as on the demonstration machine, by automatic equipment. In the magazine shown, the gears are released one at a time, and lowered, by a finger on a hydraulically-operated slide, into mesh with the cutter. Manually-loaded gears also are meshed with the cutter, and the work-head is then advanced to engage the arbor with the bore of the gear, which is subsequently clamped under light pressure while it is rotated in mesh with the cutter.

When the teeth of the gear are properly aligned with those of the cutter, the gear is clamped under high pressure, so that it can no longer rotate on the arbor, and the work-slide is moved back to the left to bring the gear clear of the cutter. Next, the work is then turned, relative to the cutter, by half the pre-determined backlash between gear and cutter, which is usually about 0·003 in. The cutter is then fed towards the work through a pre-set distance, which varies according to the amount of correction needed on the gear, and for the set-up shown was 0·010 in. With

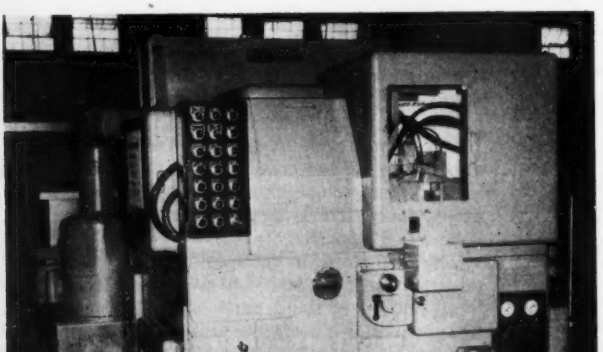


Fig. 1. On the Fellows 4BGF gear finishing machine, a flat Fellows-type cutter is employed, which can be re-sharpened on a surface grinder in the customer's works. The machine has a capacity for gears from 0·5 to 4 in. pitch diameter

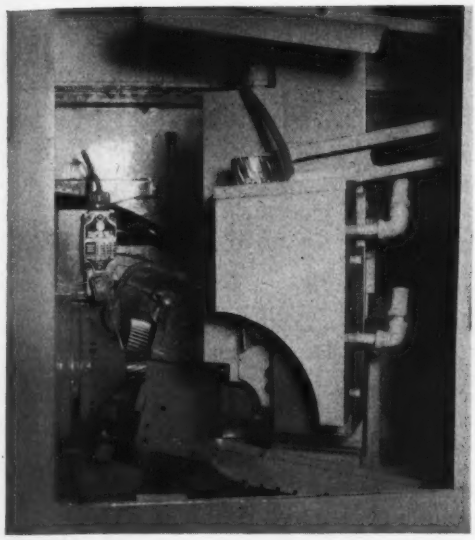


Fig. 2. In this close-up view of the new Fellows gear finisher, the magazine of the automatic loading mechanism has been swung aside to show the crossed-axis relationship between the work and cutter spindles

both spindles again running, the gear is now fed past the cutter for its full length, so that the sharp edges of the cutter teeth remove irregularities from the faces of the gear teeth.

Because the cutter is a free cutting tool, it is claimed, it can make greater corrections to inaccuracies in tooth spacing, eccentricity, and tooth profile, and can remove more stock than is possible with other finishing processes. The automatic cycle of the machine for finishing the gear shown in Fig. 2, which is of 14 d.p., with 18 teeth of 20 deg. pressure angle and 20 deg. helix angle, and has a face width of 0·906 in., is completed in 21 sec. For finishing gears with a crowned tooth form, provision is made for pivoting the cutter head during the cutting stroke.

GRADUATES' SALARIES IN U.S.A. It is reported in *Engineering and Scientific Manpower*, the news letter issued jointly by Engineering Manpower Commission and Scientific Manpower Commission, that the following monthly salaries in dollars are being accepted by this year's college graduates in the U.S.A.: chemical engineering 525; civil engineering 489; electrical engineering 536; mechanical engineering 519; natural sciences 460; and physical sciences 521.

Robinson "Bonus Clock"

In the accompanying illustration is shown a new type of industrial recording clock developed by D. Robinson & Co., Ltd., Gunnersbury House, 717 London Road, Hounslow, Middx., for which, it is stated, world patents are pending. Known as the "bonus clock" the unit is intended for installation adjacent to an operator who is working on a piecework or bonus system, and in such a position that it can readily be observed. The information presented by the clock allows the operator to check the bonus gained or lost on each individual item produced, also to ascertain the cumulative total of gains and losses at the end of a shift, for example. With the latter arrangement, the operator has an impartial record of bonus earnings at any given time.

The clock also incorporates green and red signal lights, and the former is illuminated when the operator is "in" bonus. When the operator is losing bonus, a red lamp is illuminated. A clock-type dial, the lower of the two seen in the figure, is set by the management to the time allowed for any given job, and the upper dial shows the running total of bonus time, both gained and lost. A band at the periphery of this dial is of a matte white material on which the money values of the bonus time can be written by the management.

To control the clock, a push-button may be depressed by the operator at the start of each working cycle. Alternatively, the clock can be arranged for automatic operation by means of an interlock with the machine concerned. For example, a lever connection can be made with the starting handle of the machine, or the delivery of a finished part down a chute can serve to operate a micro-switch. It has been found in practice, however, that hand-operation is usually preferred since the operator can then be certain that the clock has been set in motion and that the bonus has been recorded.

The Robinson "bonus clock" which serves to indicate incremental and aggregate bonus earnings

Electro-chemical Machining

As briefly reported in MACHINERY, 98/161—18/1/61, a demonstration was recently staged by Metachemical Processes, Ltd., at their factory at 41/47 Gatwick Road, Crawley, Sussex, of an electrolytic machining process. This process was developed during an investigation into the possibilities of using electrolytic methods for the removal of metal in shaping the cavities in forging dies. The investigations were conducted by a team led by Dr. C. L. Faust, at the Battelle Memorial Institute, under the sponsorship of the Steel Improvement & Forge Co., of Cleveland, Ohio, who have a one-third interest in Metachemical Processes, Ltd. The process is being operated in the U.S.A., by Sifco Metachemical, Ltd., a company formed specifically for the purpose, and the machines and processes which they have developed are being offered in this country on a reciprocal basis with other processes operated by the British company and its associates.

The Metachemical electrolytic machining process is based on the principle of electro-polishing, but is performed at a much faster rate, and it can also be adapted for the high-speed deposition of metal. Limits have been imposed on the removal of metal by electrolytic means in the past by the difficulties of cooling the electrolyte when heavy current densities are employed. This problem has been overcome by placing the electrode, or tool, which is the cathode, within 0·002 to 0·003 in. of the work, and pumping a special electrolyte through the space at speeds up to 90 ft. per sec. With this arrangement, current densities up to 1,500 amp. per sq. in. can be applied, and the rate of metal removal is raised to 0·05 to 0·1 in. per min.

The machine employed for the demonstration was designed, in the U.S.A., for the electrolytic machining of the aerofoil surfaces of turbine blades made from alloys in the Nimonic range. For this work, two electrodes or tools, can be used, and they are advanced towards the work from either side. A general view of the machine is given in Fig. 1, and it has a heavy-section base-plate, supported on a fabricated steel frame. At the centre of the plate there is a cross-slide which can be traversed by a handwheel and screw, and this slide carries two straight-edge cams, arranged in vee formation. Box-shaped fabricated brackets at each side of the slide support pairs of parallel cylindrical bars on which the electrode carriers can move on circulating ball bushes.

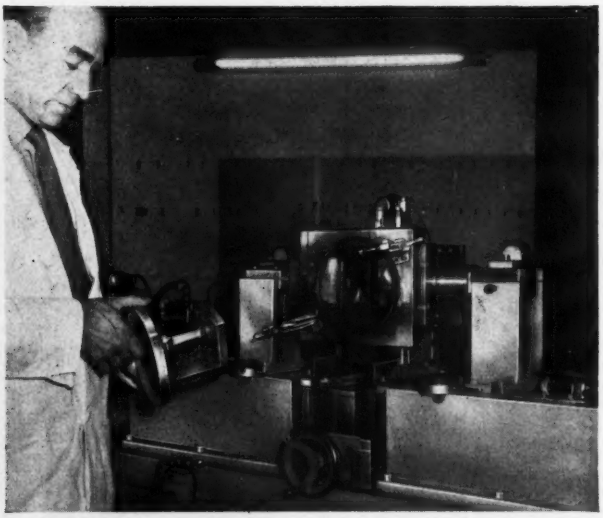


Fig. 1. This equipment for electrolytic machining of turbine blades, which was demonstrated recently, has a central fixture to hold the blade and electrode carriers at each side which are fed inwards by an air cylinder

Each carrier is urged away from the centre by a tension spring, and it has a projection, at the side nearer the centre, to carry a ball bearing roller against which the cam on the slide acts. When the slide is moved towards the front of the machine, the electrodes are simultaneously moved towards the centrally-placed workpiece. Automatic feed for the "machining" operation is provided by an air cylinder at the rear, which moves another slide carrying two straight parallel fences, arranged at a slight angle. A roller on the underside of the central slide is engaged by these fences when the air cylinder is energized, and as the rear slide is moved to the right, the central slide is advanced towards the front of the machine. The rate of feed can be regulated by means of a hydraulic check cylinder mounted in tandem with the air cylinder.

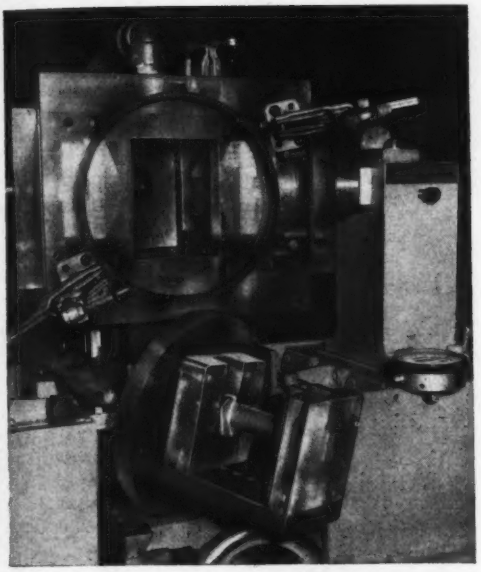


Fig. 2. A close-up view of the box-shaped fixture for electrolytic machining of turbine blades. The right-hand electrode, which is of the required form to suit one side of the aerofoil portion of the blade, is visible through the loading aperture

Thick, transparent plastics material is employed for the fixture, a close-up view of which is shown in Fig. 2. This material has the necessary insulating properties, and the fixture is box-shaped, with holes in the side walls which are a close fit for the electrode holders. At the front there is a large circular aperture through which the blade to be processed is inserted. The blade is clamped at each end in accurate locations in the plastics holder seen in the foreground, and this holder has a circular flange, which is a close fit in the fixture aperture. In addition, the aperture has a rubber ring seal to prevent leakage of the electrolyte under pressure. Two toggle clamps retain the holder in position when it has been inserted.

After the loading operation has been carried out, the handwheel is turned to advance the central slide, with the current switched off, until the electrodes are in contact with the work. For this application of the process, the electrodes, one of which is visible through the aperture in the fixture in Fig. 2, are of stainless steel, to resist the slightly corrosive action of the water-based electrolyte. Cathodic action prevents the tool from being attacked when the current is flowing. Each electrode is shaped according to the form which it is desired to reproduce on the blade, and its shape is not affected during the operation so that it has an indefinite life.

When the electrodes have been brought into contact with the work they are backed off to a distance of 0·002 to 0·003 in., an indication of their positions being given by dial gauges at the front of the carrier slides. Delivery of electrolyte from a pump in the base of the machine is then started, and it enters the fixture at the top, and is forced through the narrow spaces between the electrodes and the work. It then returns through a large-diameter tube, by gravity, to the tank, where it is filtered before being re-circulated. With the

Fig. 3. Examples of work performed by electrolytic machining including turbine blades, a half die for forging such blades, and pieces of solid tungsten carbide and Nimonic 80 through which small-diameter holes have been drilled

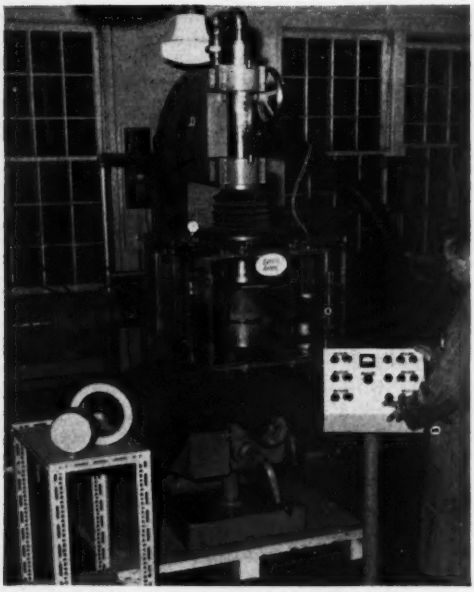


Fig. 4. Holes of round, square, hexagonal or other shapes can be trepanned on this machine. The tungsten alloy part at the left was produced by electrolytic trepanning in 5 hours

electrolyte flowing, the current is switched on, and the air cylinder which provides feed to the electrode carriers is energized.

During the demonstration, some 0·025 in. of material was removed from both faces of the aerofoil portion of the blade seen in the holder in Fig. 2, in 7 min. This blade is of Nimonic 105, and has an aerofoil portion measuring approximately 2 by ¾ in. A current density of 160 amp. per sq. in. was employed, at 12 volts, and it was estimated that irregularities in the surfaces machined were held to less than 6 micro-inches. Dimensional limits on aerofoil surfaces produced by electrolytic machining can, it is claimed, be held to 0·001 in.

Several examples of turbine blades and other parts machined by the electrolytic process are shown in Fig. 3. The die block at the left is of the type employed for forging turbine blades, and measures approximately 6 by 4 by ¾ in. In this block, the cavity was sunk from the solid on a machine of the type described earlier, to a maximum depth of 0·6 in., with penetration rates up to 0·1 in. per min., in a total time of 40 to 50 min. Dimensions of the cavity were held within 0·010 in. of the required form all over, and the surface finish has maximum irregularities of less than 10 micro-inches.

At *A* is seen a block of solid tungsten carbide—one of several on show at the demonstration—in which a hole with an average diameter of 0·020 in. has been drilled. This operation was also carried out on the machine described, but a somewhat different fixture was employed. For drilling, the tool takes the form of a short length of stainless steel tube, with a bore of 0·007 in., and an outside diameter of 0·013 in. This tube is coated with epoxy resin, for insulation, so that the effective diameter is 0·015 in., and it is fed into the work at the rate of 1·8 in. per hour. The electrolyte is pumped through the bore of the tube, at high pressure, and passes out through the space between the tube and the hole produced.

The smallest hole so far drilled in this manner, in a tungsten carbide block, has a diameter of 0·013 in., and was produced with a tube having a bore of 0·004 in., an outside diameter of 0·009 in., and a diameter over the insulation of 0·0107 in. Another drilled part displayed was a cylinder of Nimonic 80 material, as seen at the right, in which

Fig. 5. An experimental machine for cutting bars of hard materials electrolytically. The ⅛-in. thick, stainless steel, disc carries the electrolyte into the cut by centrifugal force

there are three holes within a circle of about ⅛ in. These holes have diameters of 0·0199, 0·0183 and 0·0201 in. and were also produced at penetration rates of 1·8 in. per hour. Holes could be drilled in turbine blades for the circulation of cooling air by this process. A raised cone is formed on the work at the bottom of the hole during drilling, which, it is thought, helps to guide the "drill" and thus ensure straightness of the hole.

In addition to forming and drilling, the process can be employed for trepanning and cutting-off operations, and equipment developed in America for these purposes is shown in Fig. 4 and 5. The trepanning machine in Fig. 4 has been successfully employed to cut out the core shown at the left, from a solid block of heat-resisting tungsten alloy, to produce the annular part shown. The alloy contains tungsten 85 and molybdenum 15 per cent, and the billet diameter was 10 in., and the overall length, 4½ in. Trepanning was performed with an annular tool of 7 in. outside diameter, which was fed at the rate of 0·015 in. per min., for a total period of 5 hours. It will be understood that the process is not limited to round holes.

Cutting-off operations on hard materials can be performed at roughly half the penetration rates normally obtained with diamond saws, and an American machine developed for this purpose is seen in Fig. 5. This machine is equipped with a ⅛-in. thick, disc-shaped, stainless, steel electrode, which is driven at a high peripheral speed. The electrolyte, fed on to both sides of this disc, is carried into the cut and is continuously replaced. Billets up to 20 in. diameter can be cut on this machine, and several discs could be mounted on the spindle, if required, for taking a series of cuts.

DEVELOPMENTS IN THE DALIC PROCESS

Equipment recently developed for the application of the Dalic process of electrolytic deposition of metals was also demonstrated and is shown in Fig. 6, in position on a small bench drill. The Dalic process was described in MACHINERY, 83/824—23/10/53, and it enables electro-deposition to be performed selectively, without the use of a tank of electrolyte. The equipment shown in Fig. 6 provides for the deposition of metal in bores which have worn, or been accidentally machined oversize. This equipment, it is stated, can be installed in a production line, where it is necessary to provide a bore with a hard coating, or with other properties obtainable by deposition of metal.

The plating head comprises a spindle, with a flange at each end in which aerofoil-section brushes are pivoted by integral projections on their end faces. When the spindle is lowered into the bore

Fig. 6. A plating head, here shown mounted on a bench drill, has been developed to enable bores to be plated by the Dalic process of brush deposition. The bore of the brass bush seen mounted on the machine was built up with nickel at the rate of 0·0004 in. per min.

of the bush, or other component, held in vice jaws, and rotated, the brushes are flung outwards into contact with the bore by centrifugal force. Each brush has a surface formed from perforated metal, coated with epoxy resin to serve as an insulant, and electrolyte is fed through the holes from a rotary coupling above. The brushes form the anode of the d.c. circuit, and the bush or other component is the cathode.

With this arrangement, copper, for instance, can be deposited in a bore at the rate of 0·001 in per min., and nickel at 0·0004 in. per min. Hard chromium can be deposited at 0·0003 in. per min., in bores of regular shape, and bores with recesses can also be treated. At a factory in the U.S.A., where water pump bodies are being machined in large quantities, a scrap rate of less than 1 per cent for oversize bores led to the accumulation of some 60,000 components. A set-up for salvaging these parts enabled each bore to be built up in a short cycle time, in the production area, so that the parts were cheaply reclaimed.

The Dalic process is also being used for plating of metal strip, which is passed between two brush type electrodes as it is produced.

NEWS OF THE INDUSTRY

Huddersfield

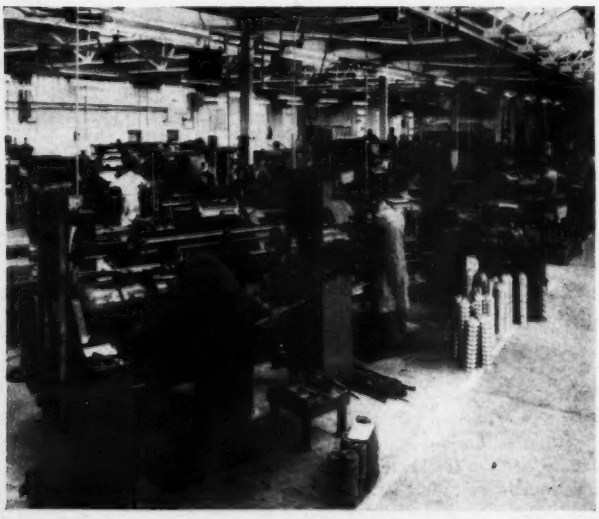
BROOMFIELD ENGINEERING CO., LTD., Folly Hall, are maintaining a high rate of production of their range of tungsten carbide slip gauges and "go" and "not go" plug gauges. The volume of orders for jigs and fixtures and special-purpose machinery, it is stated, is still at a satisfactory level. We are informed that the capacity of the works has recently been increased by the installation of a number of large milling machines.

HIGHFIELD GEAR & ENGINEERING CO., LTD., Nile Street, are extremely busy with the production of their standard range of gearing and gearboxes. The mixer drive units which this company recently introduced have proved popular and we are informed that the flow of orders for this unit is steadily increasing. For special gear units there is a very heavy demand, and this applies particularly to units of the worm gear type. To enable the works to increase output, a number of centre lathes and a Craven worm-wheel generating machine have recently been added to the plant.

KERSHAWS ENGINEERS (HUDDERSFIELD), LTD., Rashcliffe Ironworks, report a continued heavy call on their services as general pattern-makers from a wide variety of engineering companies. In particular, a large amount of machine tool work is at present being handled. The engineering department is busy with an extensive range of machining work. Capacity is available for planing up to 5 ft. wide by 20 ft. long, turning up to a maximum of 12 ft. diameter by 3 ft. wide, and up to 18 ft. long for smaller diameters. Other machining undertaken includes boring and drilling, and there are facilities for fabrication of structures up to 5 tons weight.

BROOK MOTORS, LTD., Empress Works, inform us that in their various works a high rate of production is being maintained of the various sizes and types of electric motors in their range. The position as regards export orders is reported to be very satisfactory at present. It was noted that new equipment has recently been installed in the Barnsley factory, including a Fort Wayne stator winding machine of the automatic type.

DATHAN TOOL & GAUGE COMPANY, Thornfield Works, Thornfield Road, Lockwood, report a steady flow of orders for their range of gauges which includes vernier height and gear tooth types. Numerous orders are at present in hand for gear shaper cutters and generating cutters for straight bevel gears. New equipment recently installed in the works includes a 7½-in. centre lathe, a Jones & Shipman surface grinder and a new



A view in the 12,000 sq. ft. extension which has recently come into full production at the Ipswich Road Works, Slough, of W. J. Meddings, Ltd. With this addition, the total floor space now approaches 50,000 sq. ft. and the increased facilities will enable the company to improve deliveries to meet the sustained demand for drilling machines, air hydraulic feed units, unit drill heads, special-purpose machines, and associated equipment

grinding machine for the generation of gear shaper cutters. We are informed that the products of this company are now in good demand from a number of countries, including India and Canada.

PLANERS (HUDDERSFIELD), LTD., Lockwood, are able to report a marked increase in the volume of orders received during the past year, and especially since the Machine Tool Exhibition at Olympia. Machines at present in production include double column planers up to 8-ft. width capacity, with strokes ranging up to 36 ft., open-side planers up to 5-ft. capacity, and a number of machines fitted with milling heads ranging from 3 to 15 h.p.

HOPKINSONS, LTD., are busy with the production of a wide range of valves for power station use, for both the home and export markets. A large number of valves of varying types and sizes is also in hand for marine applications, and we are informed that there has been an increasing demand for such valves in recent months. The foundry is maintaining a steady output of steel castings for use in the company's works, and castings are also produced for a number of customers in the district.

The oil purifying department is occupied on a wide range of separator units for various types and grades of oil, and work now in progress includes a number of units for purifying lubricating and cutting oils.

To enable the despatch department to handle the increasing number of products which is destined for export a new warehouse has recently been built. Another addition to the premises is an apprentice training school, the buildings for which have now been completed. Modern machines and equipment are at present being installed.

THOMAS BROADBENT & SONS, LTD., are working at high pressure on their range of products which includes centrifugal clutches, couplings, brakes, and centrifugal extraction machinery for the sugar, chemical, and laundry industries. Sugar centrifugals are in very heavy demand, export orders being in hand for the supply of batteries of these machines to the U.S.S.R., South Africa, Australia, South America, and the West Indies.

A works extension of some 19,200 sq. ft. has recently been completed and is to be used for the manufacture of dry cleaning plant and equipment. This equipment, it may be noted, is now being made and marketed by the subsidiary company Broadbent-Versatile, Ltd.

A further factory extension is now in hand to provide increased capacity to meet the demand for various types of centrifugals. The plant in the centrifugal basket manufacturing department was recently augmented by the addition of a large capacity Denham's centre lathe.

R. SUTCLIFFE.

London and the South

A.R.O. MACHINERY CO., LTD., 190 Castlenau, S.W.13, report that they are still busy with enquiries and orders for electric resistance welding machines of fixed and portable types. There

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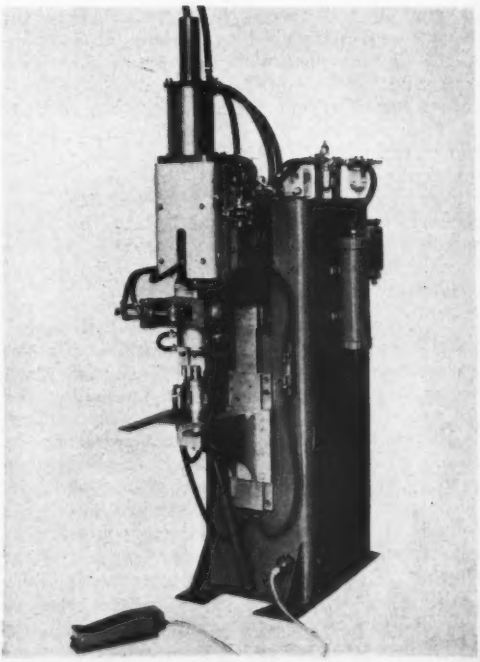
The high speed stitch welding machine, with high lift head, shown in the figure, has been introduced by The British Federal Welder & Machine Co., Ltd., Castle Mill Works, Dudley, Worcs., for such operations as welding filler caps to petrol tanks, and sumps to washing machine bodies. Loading of dished type components is facilitated with the high lift head, and the upper electrode is constrained to move in a circular path to produce an overlapped stitch weld by a high speed, air-operated indexing system. A wide variety of tooling can be fitted and it is stated that gas tight joints can thus be produced on components which do not lend themselves to seam welding



is a good demand for the A.R.O. hand-operated, water-cooled, spot welding machines, which are frequently suspended from overhead mountings so designed as to afford mobility in operation. Such welding machines are held in ring mountings which enables the electrodes to be presented to the work at any desired angle. Orders for equipment of this type have been received, for example, from firms producing refrigerator cabinets and car bodies. Interest is also being shown in the unit-type welding head of compact form, which the company produces for fitting into customers' fixtures and special-purpose machinery.

SOLEX GAUGES, LTD., 72 Chiswick High Road, W.4, inform us that orders are well maintained for Solex air gauging equipment which is of simple basic design and is widely employed in workshops for internal and external measurement. Several interesting air gauging fixtures are at present in progress, one of which is provided with 12 columns, to give readings, simultaneously, of measurements taken on a crankshaft at several points. Upper and lower limit markers, fitted to each column, enable an inspector to observe at a glance whether the readings are within the permitted tolerances.

Another air gauging fixture is provided with a magazine which feeds parts to a measuring station for grading and thence to a 3-way chute for delivery into separate bins. Many air-jet plug gauges are provided with tungsten-carbide wear strips, and can be employed for extended periods without loss of accuracy. Another method adopted for increasing the life of Solex gauging heads involves protection of the wearing surfaces with tungsten carbide applied by the flame plating process by John Harris Tools, Ltd., Warwick. New machine tools have been installed in the shops including a Jones & Shipman universal grinding machine, a Colchester Triumph centre lathe, and a Hardinge precision lathe.

G.R.M. HEAT TREATMENTS, LTD., Park Royal, N.W.10, have greatly improved facilities for the heat-treatment of a wide variety of parts since they moved from premises in the Paddington district two years ago. Among the work undertaken may be mentioned flame-hardening, by the Shorter process, of machine tool bed-ways, teeth of gears up to 60 in. diameter, and cams of various types. This company employs specially-developed methods and equipment for reducing distortion in heat-treated disc-shaped parts, for example. Stress relieving of weld-fabricated structures and the annealing of light alloy parts in temperature-controlled furnaces are frequently carried out, also special heat-treatment of gears, stub axles, camshafts, shackle pins, and other highly stressed parts for racing cars. Large quantities of springs and contacts in beryllium copper are regularly received for heat treatment. A new bay has recently been constructed to provide an additional 1,500 sq. ft. of floor space for salt bath furnaces.

DOWDING & DOLL, LTD., 346 Kensington High Street, W.14, recently held two exhibitions in Manchester at which a variety of sheet metal working machines and machine tools was demonstrated. Both exhibitions, to which attention was drawn in MACHINERY, 97/1433—21/12/60 and 97/1487—28/12/60, are stated to have attracted many visitors, and various orders were placed. A British-built Wiedemann RA 41P turret punch press with a 24-in. by 24-in. capacity pantograph table, an R 44 template-controlled punch press, and an R 4 hand-operated bench press, together with other machine tools, are to be shown at the forthcoming Leipzig Fair. We may also note that two RA 41 P turret punch presses, one with a 24-in. by 24-in., and the other with a 40-in. by 28-in. table, and Dowding V.10 and H.7 gear hobbing machines, will be displayed at the British Trade Fair in Moscow.

ANDREW FRASER (EALING), LTD., 27 The Vale, W.3, are still very busy with orders for contract machining to close tolerances. Facilities are available for a wide variety of machining operations including the grinding of parts of non-circular cross section, for which purpose a Polygon machine by Manurhin is employed. Additional capacity for honing has recently been provided by the installation of a Kitchen & Wade vertical machine, and other additions to the plant include a Hydetsco planing machine and a planetary type internal grinding machine by Churchill Machine Tool Co., Ltd. Planning permission has been obtained to extend the existing works buildings and thus provide additional floor space for production purposes.

HORNAMILL MACHINE TOOL CO., LTD., 238 Dawes Road, S.W.6, are experiencing a steady demand for the Hornamill universal head which is now widely employed in engineering shops. This self-contained head incorporates an electric motor and the V-pulley and belt transmission permits a choice of spindle speeds from 328 to 4,000 r.p.m. A universal clamp enables the cutter to be presented to the work at almost any desired angle, and provides for attachment of the head to lathes, milling machines, planing machines, and surface plates.

J. HORNAL, 238 Dawes Road, S.W.6, are busy with the production of a wide variety of knives in stainless steel and other alloys for applications

concerned with the processing of food, paper, and many other materials.

Other work in progress includes the production of light pressings, on a Norton 50-ton hydraulic press, and ground stainless steel strips of rectangular section for checking waveguides. It may be noted that this company also makes pneumatic die cushions for presses. Machine tools installed during the past year include a Victoria V 2 vertical milling machine, and an Elb surface grinding machine, with a table capacity of 33 in. by 10 in.

HICKS MACHINERY, LTD., Addison Place, W.11, are receiving enquiries for Magdeburg type D 30 production lathes and type DH 300 automatic copy-turning lathes, the latter being intended for machining motor car components, for example. Both lathes are designed for operation at spindle speeds up to 1,500, 2,000, or 3,000 r.p.m. When required, the DH 300 machine may be fitted with a magazine, whence faced and centred bars are loaded in a fully-automatic cycle.

JOHN PRESTON & CO., LTD., Sarsfield Road, Perivale, Middlesex, are steadily expanding the sales of their range of standard plating jigs and replaceable wire forms which are now widely employed in the electroplating and anodizing industries in the United Kingdom and a number of foreign countries. The jigs and wire forms are coated with a chemically inert plastics material except at the points of electrical contact, and the accumulation of excess deposited metal during plating is consequently much reduced. A considerable amount of business is done with firms who require plating jigs and wire forms of special shapes to suit particular components. This company has supplied jigs made from titanium for use in anodizing baths on account of the high resistance offered by this metal to corrosive fluids.

LAKE & ELLIOT, LTD., Albion Works, Braintree, Essex, who recently reached their 50th anniversary, are busy with the production of iron, steel, and alloy castings for a wide range of applications. The iron foundry is engaged on castings for refrigeration unit cylinder blocks and other pressurized parts. It may be noted that castings in S.G. iron are produced under licence from Mond Nickel Co., Ltd. The steel foundry, which is the largest department in the works, and the alloy foundry, are well equipped to produce castings for the oil industry, railways, nuclear power installations and civil engineering, for example.

Extensive use is made of electric furnaces of different types, and it is stated that the company installed an electric arc furnace for the production of steel castings as long ago as 1910. It may be noted, also, that hydraulic jacks were first supplied to the motor trade in 1923. Subsequently, the Millenium range of jacks for motor vehicle and aircraft use was developed. A fully equipped shop has been provided for machining castings to customers' requirements, and facilities are available for physical and radiographic testing. A new laboratory is scheduled for completion during this year.

MOLLART ENGINEERING CO., LTD., Kingston Bypass, Surbiton, Surrey, are maintaining a steady output of their ME patent and Hooke's type universal joints which have numerous applications in the engineering industry. The former joint is produced in a range of nine sizes to suit shafts from ¼ in. up to 1⅝ in. diameter. This company has a well-established reputation for the design and construction of special purpose equipment and in this connection it may be noted that grinding machines and broaching machines for specific applications have recently been built. Activities also include the production of high frequency grinding units and the latest versions introduced can be supplied with speeds up to 90,000 r.p.m.

It is understood that the range of work undertaken is soon to be extended to include the building of in-line transfer machines. Facilities for such work will be improved with the completion of a new drawing and design office which is now under construction at the rear of the factory buildings.

F. W. HERRIDGE.

Fitting the Job to the Worker

A paper on ergonomics, under the above title, was recently presented by C. B. Frisby, Ph.D., director, National Institute of Industrial Psychology, at the Royal Society of Arts, John Adam Street, Adephi, London, W.C.2.

In his opening remarks, Dr. Frisby briefly outlined the history of ergonomic studies and stressed the need for taking research results into account in connection with industrial working conditions and the design of tools and machines.

In the sphere of occupational hygiene, it had been shown that although adverse conditions of lighting, heating, ventilation, noise, and vibration did not prevent work from being carried on, they did cause marked decreases in efficiency. Following tests in the hot conditions of a tinplate works, for instance, graphs had been drawn which established an inverse relationship between productivity and temperature rise.

Turning to the question of shop equipment design, Dr. Frisby referred to the advantages to be derived from the use of work-benches with proper height adjustment. He mentioned an installation

of assembly lines which was provided in the earlier part of the century at the Ford plant in the U.S.A. Separate lines with two different working heights were laid down to suit tall and shorter men. The varying capacities of reach and strength of workers must be considered, he said, in relation to plant and equipment controls. Similarly, the forces that different people could comfortably exert frequently throughout a working shift must be taken into account in designing lever-operated mechanisms.

Concluding with a general reference to machinery, Dr. Frisby condemned the design, from an ergonomic aspect, of the average small power press, which, in his opinion, involved a position of considerable discomfort for the operator. Attention had been drawn to this state of affairs as long ago as 1923 by the Industrial Fatigue Research Board, but because of human adaptability to unnatural postures, little, if any, improvement had been made.

Earnings in U.S. Machinery Industries

Results of a survey of earnings of production workers in non-electrical machinery manufacturing industries in the U.S.A. are summarized in the December, 1960, issue of the *Ministry of Labour Gazette*. The survey covered establishments building machine tool accessories that employed eight or more workers, and other machinery building establishments that employed 20 or more workers, in 21 areas.

This survey showed that average straight-time hourly earnings of production workers had risen by 4·1 per cent during the preceding year, and by about 135·2 per cent since January, 1945. Wage movements varied from area to area, and between skilled and unskilled occupations included in the survey. Earnings of tool and die makers (in other than jobbing shops) showed a greater increase than those of unskilled workers. A long-term trend that has narrowed the differentials in pay levels between the two groups was thus reversed.

In the accompanying table are shown the average straight-time hourly earnings of men in selected occupations in certain American cities for the period December, 1959, to May, 1960, also the range of averages for the 21 areas included in the survey. An exchange rate of $2·80=£1 was assumed.

In one area, slightly more than half the production workers had a scheduled working week of more than 40 hours, but for the majority of workers in the other areas, the working week was 40 hours. In the 21 areas combined, 18 per cent of the workers were employed on late shifts, and most received pay differentials which varied greatly, the most common amount being 10 per cent more than normal day-shift rate. Virtually all workers had paid holidays (annual and public), and some type of insurance or pension scheme, the amount of holiday pay varying with length of service. Nearly all workers had one week of paid holiday after one year of service, and more than 80 per cent received two weeks of paid holiday after five years. With the exception of one area, 60 per cent of the workers had three weeks of paid holiday after 15 years, and in two areas more than 50 per cent had at least four weeks after 25 years' service had been completed.

Life insurance, hospital and surgical schemes were available to more than 80 per cent of the workers in virtually all areas, and in more than half the areas 70 per cent or more workers were in establishments with medical insurance schemes that provided complete or partial payment of doctors' fees. Sick-leave payment schemes, however, were applicable to less than 10 per cent of workers in all but five areas. The proportion of production workers covered by retirement pensions varied greatly between areas, and ranged from 25 per cent in one area to 90 per cent in another.

SUMMARY OF RESULTS OF A SURVEY OF EARNINGS IN MACHINERY INDUSTRIES IN FOUR CITIES IN THE U.S.A. WITH THE RANGE FOR THE 21 CENTRES COVERED BY THE SURVEY

Occupation	Average Hourly Earnings				
	Chicago	Detroit	Los Angeles-Long Beach	New York City	21 centres (range)
	s. d.	s. d.	s. d.	s. d.	s. d. s. d.
Assemblers, class A	19 9	21 11	18 11	18 3	14 10–21 11
B	17 7	18 5	15 9	15 2	12 4–19 2
C	15 0	17 3	13 9	14 3	10 3–17 6
Electricians, maintenance	21 5	22 10	20 5	19 9	17 1–22 10
Inspectors, class A	19 8	22 3	19 7	19 9	16 9–22 7
B	17 8	18 10	16 11	16 0	13 9–19 9
C	17 2	17 7	14 9	11 9	11 9–17 11
Machine tool operators, Production class A	20 1	22 4	19 8	18 3	16 3–22 4
B	18 2	18 9	16 8	15 3	13 6–18 10
C	15 5	16 11	14 4	13 0	11 10–17 1
Machine tool operators, toolroom	19 7	24 11	20 9	18 9	16 8–24 11
Machinists, production	—	—	20 3	19 9	16 9–22 9
Tool and die makers—					
Jobbing shops	24 6	25 6	22 3	19 10	19 3–25 6
Others	22 3	23 7	21 8	20 4	18 1–24 11
Welders, hand, class A	19 7	20 6	19 9	18 3	15 2–21 1
B	17 9	19 0	16 9	16 5	12 7–19 2
Janitors, porters, cleaners	14 1	16 3	13 11	12 8	10 2–16 3
Labourers, material handling	14 9	17 3	14 9	13 3	10 1–17 4

The Outlook for Steel

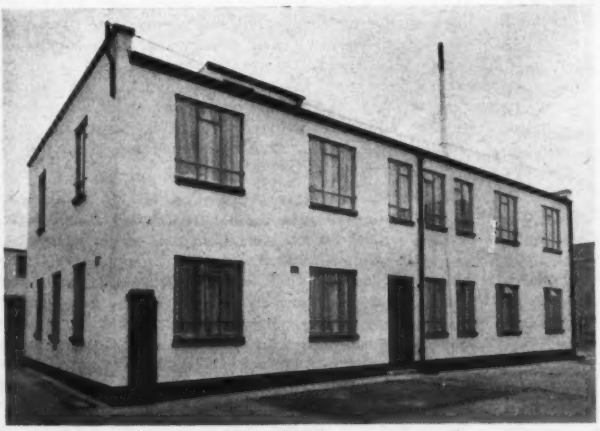
(*Continued from page* 175)

term demand, but also to allow for "reasonable medium-term fluctuations in requirements as well as stronger seasonal movements in particular sectors." The average manufacturer in the metal working industries who has long become accustomed to being told, in any period of normal trading, that he cannot have the steel he needs when he wants it will take careful note of these words. There is no doubt that the availability of consistently adequate supplies of steel of all the qualities and forms normally and reasonably required would do much to improve the competitive position of British manufacturers of metal goods, both in the home and export markets.

New Offices for M. C. Layton, Ltd.

The illustration gives a view of the new 2-storey office building which has recently been completed at the premises of M. C. Layton, Ltd., Alperton, Middlesex. Situated adjacent to the showroom for the various types of machine tools which the company handles, the building has a total floor area of 2,100 sq. ft., and provides accommodation for the sales and administrative staff. Sound insulation has been used in the floor to reduce the transmission of noise, and all north side lights are double glazed.

When the company vacated their premises in Victoria Street, London, S.W.1, in 1959, temporary offices were built within the showroom and covered about one-third of the floor area which amounts to some 9,250 sq. ft. With the completion of the new building, this floor area has again been made available to permit an increased range of machine tools to be displayed, and it is proposed to provide an enclosed space for demonstrating G.K.N. spark erosion machines.



A view of the new office building of M. C. Layton, Ltd.

Oxy-acetylene Welding Standard

A revised British Standard (B.S. 693:1960) covering general requirements for oxy-acetylene welding of mild steel is intended to be applicable to all forms of structures other than pressure vessels and pressure pipe-lines for which there are special standards. It is concerned with welding of general purpose mild steel having a tensile strength not exceeding 33 tons per sq. in., and containing not more than 0·25 per cent carbon, 0·060 per cent sulphur, and 0·060 per cent phosphorus.

Requirements are laid down for butt welds, fillet welds, cleanliness of fusion faces, and workmanship, together with appropriate tests.

Appendices to the specification give information on distortion control, butt weld bend tests, fillet weld fracture tests, and flame conditions, and include a suggested method of preparing etched specimens.

Copies may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1 (price 6s., postage extra to non-subscribers).

Coming Events

INSTITUTION OF MECHANICAL ENGINEERS. *Southern Branch Graduates Section.* January 31, at 6.30 p.m., at Portsmouth College of Technology, Anglesea Road Annexe, Portsmouth. Chairman's address, "Planned Maintenance in a Light Engineering Plant," by M. Haward.

THE PLASTICS INSTITUTE. *North-Western Section.* February 3, at 6.45 p.m., at the Textile Institute, 10 Blackfriars Street, Manchester 3; lecture on "Plastics in Industry—Domestic Appliances," by H. J. Sharpe, M.Sc., Ph.D.

INSTITUTION OF PRODUCTION ENGINEERS. *Nottingham Section.* February 1, at 7 p.m., at the Reform Club, Victoria Street, Nottingham; lecture on "Lubricants in Manufacturing Processes," by W. G. Medlock. *Manchester Graduate Section.* February 6, at 7.15 p.m., at Reynolds Hall, Manchester College of Science and Technology, Manchester; lecture on "Production Engineering Research in the Soviet Union," by R. Tilsley. *London Section.* February 2, at 7 p.m., at the Royal Commonwealth Society, Northumberland Ave., W.C.2, "Materials Handling in Production Processes and Stores," by R. G. Winton. *Rochester Graduate Section.* February 2, at 7.30 p.m., at the Sun Hotel, Chatham; lecture on "Manufacture and Application of Ball and Roller Bearings," by T. S. Nisbet.

Industrial Notes

DAVID ETCHELLS (MACHINERY), LTD., have moved to new premises at Stafford Road, Darlaston, South Staffs. (telephone, James Bridge 2461).

E.M.O. INSTRUMENTATION, LTD., Western Road, Bracknell, Berks. Slide chart giving dimensions for the various sizes of R series deep groove, low torque, ball bearings of both open and shielded types. Performance data are conveniently presented on the reverse side.

CLAUDE LYONS, LTD., Valley Works, Hoddesdon, Herts., are the sole agents in this country for Strobotac type 1531-A stroboscope unit made by the General Radio Co., West Concord, Mass., U.S.A. This instrument was described in MACHINERY 97/668—21/9/60.

THE HOLMAN GROUP, Camborne, Cornwall, have opened new offices and a showroom at 8 King Street, Bristol, to serve an area comprising: Gloucestershire (east of the river Severn), Wiltshire, Somerset, Dorset and Devon.

AN AUCTION SALE OF MACHINE TOOLS and miscellaneous stores from the W.D. Storage Depot, South West Stores, Luxton Lane, Chorley, Lancs., will be held at Cheetham Town Hall, Manchester, 8, on March 7. The auctioneers will be J. H. Norris & Son (Dept. N), 9 Albert Square, Manchester, 2.

J. P. UDAL, LTD., Interlock Works, Court Road, Birmingham, 12, inform us that last year their press guard inspection and maintenance service covered some 5,000 presses belonging to 243 customers. This service, for which a nominal fee is charged, is available, it is pointed out, to all press users, regardless of the make of guard fitted.

THE 13TH BRITISH ELECTRICAL POWER CONVENTION will be held at Eastbourne from June 12 to 15 under the presidency of Sir John Pickles, B.Sc., M.I.E.E. The theme will be "Electricity in the Prosperity and Welfare of the Nation." Further information can be obtained from the Electrical Development Association, 2 Savoy Hill, London, W.C.2.

SHAWFORD CONTROL GEAR CO., LTD., Midland Terrace, Victoria Road, Willesden, London, N.W.10, has been formed to import into this country from Italy the CEMA range of heavy-duty electrical control units, pilot lights, selectors, pedal switches, palm switches, limit switches, contactors, isolators, timers, latched relays, terminal blocks, solenoids and micro-switches.

W. VEENSTRA & CO. (ENGLAND), LTD., is the name of a new company that has been formed to handle the sales of the complete range of hand and power operated bending machines for tubes, bars and profiles, built by W. Veenstra & Co., Amsterdam, Holland. Mr. G. W. Blum will be responsible for the management of the new company, the address of which is 14 Valencia Road, Stanmore, Middlesex (telephone, Grimsdyke 2611).

THE CROWTHORN ENGINEERING CO., LTD., Atlas Works, Reddish, Nr. Stockport, inform us that they have received an order from the United Kingdom Atomic Energy Authority for six Crowthorn lathes for the apprentice training centre at the Dounreay Experimental Reactor Establishment, Thurso, Caithness. Of 7½-in. centre height, these lathes will have a length capacity of 3 ft. 6 in. between centres, and spindle speeds up to 1,000 r.p.m.

R. H. COLE (OVERSEAS), LTD., 2 Caxton Street, Westminster, London, S.W.1, have been appointed sole agents for the range of machines for the electrical industry built by Luther & Jordan, Braunschweig, Germany. This range includes various types of coil winding machines, a toroidal taping machine, a taping attachment for use in conjunction with winding machines, a bushing winding machine, a lacquering machine, a paper coating machine, and a deburring machine.

SMART & BROWN (MACHINE TOOLS), LTD., 25 Manchester Square, London, W.1.—In MACHINERY, 98/101—11/1/61, reference was made to forthcoming changes in connection with the range of Smart & Brown lathes. As a result of these changes, the following are being withdrawn: 9-in. swing precision bench lathes, types SABEL, SAB, and S, also the type M lathe, which, it should be noted, is not air-operated as was stated in the note referred to above. Production of the model A lathe, of 4½-in. centre height, will continue.

THE SUFFOLK IRON FOUNDRY (1920), LTD., Stowmarket, Suffolk, have issued Chart No. 2 of the series for Sifbronze welding data and instruction. It gives conversion factors and tables, temperature scales, flame temperatures, gas values, melting points and welding data for Sifbronze welding of mild steel also mild steel fusion welding. In addition, common defects in welding and forms of welding joints are illustrated. Copies may be obtained from the above address on payment of 2s. to cover cost of packing and postage.

WOLF ELECTRIC TOOLS, LTD., Hanger Lane, Ealing, London, W.5, it is reported, are saving considerable time in connection with export packing by employing 10 standard sizes of lightweight plywood cases, which will accommodate nearly all of the 52 different power tools in their current export catalogue. These cases, which are supplied by Venesta Plywood, Ltd., are of the normal 201N type made by that company, with riveted metal edging for corner reinforcement. Internal dimensions range from 50¼ by 28½ by 21¼ in. to 33 by 30 by 13¼ in.

SUGGESTION AWARD.—Mr. Ernest Hall, a leading hand in one of the plating shops at the Patchway, Bristol, works of Bristol Siddeley Engines, Ltd., was recently presented with the sum of £100 for the best suggestion of 1960. An initial award of £50 was made to him when the suggestion was accepted in July. Mr. Hall designed and made a special spray gun for applying aluminium paint to fir-tree root slots in compressor and turbine discs. The use of this gun, it is stated, has enabled considerable time to be saved, as compared with the previous method of applying paint with a small brush.

THE ENGLISH ELECTRIC CO., LTD., have formed a Reinforced Plastics Division, which is established at the

new Freckleton Works, Mill Lane, Warton, Lancs. (telephone, Freckleton 521). The range of manufactures includes aircraft, traction and rolling stock components and numerous items hitherto produced by various small units operating within the Group. As far as possible the work will be mechanized, and in addition to meeting the requirements of the group, reinforced plastics parts will be made on a commercial basis to meet the requirements of outside organizations.

Among the items which the Division is equipped to manufacture are large pressure mouldings up to 15 ft. by 12 ft., filament wound tubes, pipes, and pressure vessels.

STEEL AND IRON PRODUCTION.—It is announced by the Iron and Steel Board that the output of steel in 1960 amounted to 24,305,000 tons. This figure was 20 per cent higher than the total for 1959, and 12 per cent higher than the previous record production achieved in 1957. In December, output averaged 451,100 tons per month, or 4 per cent more than the highest figure previously achieved for this month.

The production of pig iron in December, at an average of 306,000 tons per week, was also a record for the month, and the total output for the year (15,763,000 tons) exceeded the highest figure previously reached (in 1957) by 10 per cent.

DAVY AND UNITED ENGINEERING CO., LTD. (a member of the Davy-Ashmore Group) and THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LTD. (a member of the Brightside Group) have together secured a contract valued at slightly more than £2¼ million, to build rolling mills for the new Tinsley Park Works of English Steel Corporation, Ltd. The Tinsley Park project, which will involve an estimated cost of £26 million, is stated to be the largest single industrial development so far undertaken within the city of Sheffield.

This new plant, which is expected to be in full operation early in 1963, will treble billet output by English Steel Corporation, raising it from 130,000 to 380,000 tons a year, and will also enable more economical production to be obtained.

ENGINEERING AND ELECTRICAL GOODS—ORDERS AND DELIVERIES. The Board of Trade reports that new orders continued to be received in the industries producing engineering and electrical goods (Order VI of the Standard Industrial Classification), locomotives and railway track equipment, railway carriages and wagons, heavy commercial vehicles, and wheeled tractors, in October, at about the same rate as in the second and third quarters of the year. Deliveries, however, increased rapidly, and mainly seasonally, in the early autumn months, and in October were about the same as net new orders. The volume of orders on hand has changed little since the end of August.

In the engineering and electrical goods industries the volume of production in October was, it is estimated, 2 per cent more than in October, 1959. The whole of the increase was in industries producing capital goods where output was still expanding though at a slower rate than in the early months of 1960. During the third quarter, manufacturers' deliveries of engineering consumer goods, other than domestic refrigerators which were approaching the seasonal trough, seem to have stopped falling after the sharp decline in the second quarter.

MACHINERY'S ENQUIRY BUREAU

For many years MACHINERY has provided an enquiry service not only for subscribers and advertisers but for all engineers in need of such information as the names of makers—or their agents—of machines or equipment for performing particular operations, suppliers of various classes of material, firms with facilities for undertaking certain types of work, owners of trade names, and agents for foreign machine builders. If you have such a problem write (MACHINERY, Enquiry Bureau, Clifton House, 83-117 Euston Road, London, N.W.1) or telephone (Euston 8441, 2 lines). This service is, of course, entirely free.

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Personal

MR. J. A. PULL, engineering manager of Vickers-Armstrongs (Aircraft), Ltd., Weybridge, Surrey, has been appointed a special director of the company.

MR. E. W. DIXON has been appointed assistant works manager at the Greenock, Scotland, factory of IBM United Kingdom, Ltd.

MR. K. E. WEST is to be appointed managing director of Earle, Bourne & Co., Ltd., Heath Street South, Birmingham 18, in succession to Mr J R. Roby, who has resigned from this position.

MR. P. W. SELIGMAN has been appointed deputy chairman of The A.P.V. Co., Ltd., Manor Royal, Crawley, Sussex, while retaining his position of managing director. MR. H. P. N. BENSON has also been appointed a managing director.

MR. JOHN BAILEY has recently retired from the position of sales director of Brook Motors, Ltd., Huddersfield, but is to remain on the board as technical consultant. The post of sales director, home market, is now held by Mr. David Brook, and Mr. G. H. Brook has been appointed sales manager.

MR. E. SMITH has been appointed works manager of Precision Machinery Services, Ltd., a subsidiary of Modern Machine Tools, Ltd., Gosford Street, Coventry, which specialises in the reconditioning of used machine tool equipment. Mr. Smith was recently with the Denfords Engineering Co., Ltd., Halifax.

MR. J. R. BICKERTON, chief chemist at the Hyde plant, MR. J. BIRCHENOUGH, works manager at the Hyde plant, MR. R. A. MILLER, divisional sales manager in the North London Division, and MR. S. V. TILLEY, senior technical representative in the Midlands and South Wales, have been appointed directors of Fletcher Miller,* Ltd., Alma Mills, Hyde, Cheshire. MR. D. W. HOWE is now Northern Area manager of the Engineering Division of the company.

MR. H. B. MORRIS has been appointed a director of Wickman, Ltd., Banner Lane, Coventry. He joined the company in 1938 and served with the R.A.F. from 1939 until 1944. A Battle of Britain fighter pilot attached to 92 Squadron, Biggin Hill, he was shot down over France in 1941 and lost his right arm. He returned to Wickman, Ltd., in 1944, following his repatriation.

In 1948 Mr. Morris was transferred to a subsidiary, Arc Manufacturing Co., as chief accountant and was later appointed secretary to that company. He became secretary to the parent company in 1955. Mr. Morris is a Fellow of the Institute of Costs and Works Accountants.

Mr. H. B. Morris

MR. A. R. MARGIN has been appointed export sales manager of Landis Machine Co., Waynesboro, Penn., U.S.A., following the retirement of Mr. J. M. McNeal.

MR. W. BRUCE, London manager of Opperman Gears, Ltd., Newbury, Berks., has been appointed sales manager of the associated company, LimiTorque Valve Controls, Ltd. He will continue to operate from the London office at 1 Newton Street, W.C.2.

MR. J. ATHERTON has joined William Asquith, Ltd., Highroad Well Works, Halifax, a subsidiary of Asquith Machine Tool Corporation, Ltd., as a director and chief engineer. Until recently, he was chief engineer with Kendall & Gent, Ltd., and had been with that company for 22 years.

MR. A. JOHNSON is relinquishing his position as chief engineer with William Asquith, Ltd., but is retaining his seat on the board and will act as consultant and concern himself with general development work for the Group. His headquarters will be at the above address.

Scrap Metals

*LONDON.—†Prices per ton for non-ferrous scrap metals free from iron are as follows:—Clean copper wire, untinned and free from lead and solder, £187; clean heavy copper, untinned and free from lead and solder, £181; copper wire No. 2, £175; clean light copper, £171; braziery copper, £163; gunmetal, £167; brass, mixed, £118; lead, net, £50; zinc, £41; cast aluminium, £97; old rolled aluminium, £100; battery lead, £24; unsweated brass radiators, £95; hollow pewter, £535; black pewter, £410.

MIDLANDS.—Outlets are available for all grades of scrap in and around the Midlands and merchants are delivering substantial tonnages each week. The recession in the motor trade has reduced tonnages of scrap available weekly from some factories by more than 50 per cent and merchants have found it necessary to concentrate on deliveries from their yards. Stocks are falling in local yards and in consequence there has been increased competition for the parcels of iron and steel scrap put out for tender by Government Departments and Councils.

Heavy steel intake is substantial at local steelworks for basic grades, with limited acceptances of low S. & P. scrap in furnace sizes. Blast furnaces are accepting all the Midland supplies of bushy and chipped steel turnings as well as compressed destructor bales. Cast iron borings are moving steadily to both blast furnaces and chemical works. Demand for cast iron scrap is keener than ever, and merchants' representatives are searching daily for all grades from light to machinery quality to satisfy foundry requirements.

To keep their presses in operation, merchants are offering top prices for all light scrap. New production light steel cuttings, in particular, are sought, also light iron and loose destructor scrap. Oversize steel and cast iron for processing to steelworks and foundry sizes commands good prices, and is urgently required to replace the falling yard stocks if deliveries to consumers are to continue at a satisfactory level.

* George Cohen, Sons & Co., Ltd., 600 Wood Lane, London, W.12.
† Subject to market fluctuations.

Machine Tool Share Market

Stock markets were quiet during the period under review, but after being dull and uncertain for the most part, developed a rallying tendency and finished on a steady to firm note.

The gilt-edged section received small investment support, and on balance there were fractional gains among British Funds and kindred issues.

In commercial and industrial share markets, conditions were mixed, with buying interest moderate and selective. Early easiness gave place to a brighter trend, and by the close a number of gains were recorded, and numerous good features were in evidence.

Among machine tool issues, Birmingham Small Arms advanced 1s. 6d. to 40s. 6d.; Brooke Tool, 7½d. to 6s. 6d.; Chas. Churchill, 3d. to 7s. 7½d.; Greenwood & Batley, 1s. 3d. to 26s. 3d.; Alfred Herbert, 3s. 1½d. to 56s. 3d.; John Holroyd "A," 1s. 3d. to 16s. 3d.; Kerry's (Gt. Britain), 3d. to 9s. 6d.; Newall Engineering, 3d. to 6s. 3d.; Ambrose Shardlow, 1s. 3d. to 45s.; John Shaw & Son (Wolverhampton), 1½d. to 16s. 3d.; and Sheffield Twist Drill, 3d. to 15s. 6d. On the other hand, Asquith Machine Tool lost 6d. at 11s. 6d.; Craven Bros. (Manchester), 1s. at 9s. 10½d.; and John Harper, 1½d. at 8s. 1½d.

Russian Order for Matrix Machines

Mr. J. M. Brice, divisional director, and Mr. D. G. Walder, of Coventry Gauge & Tool Co., Ltd., Fletchamstead Highway, Coventry, recently returned from Moscow where they negotiated a contract valued at more than £250,000 for the supply of a total of 34 Matrix precision thread, gear, and jig grinding machines.

This is the second large order secured in recent months from the U.S.S.R. by Coventry Gauge & Tool Co., Ltd., in the face of keen competition from German and Swiss firms, and the total value of Matrix machine tools involved is in excess of £500,000.

In addition, the company has received substantial orders from Japan. As further evidence of the success of Coventry Gauge in overseas markets we may note that, even before the latest Russian contract had been placed, export business accounted for slightly more than half the total of orders for Matrix machines booked during the past 12 months.

Obituary

MAJOR J. W. BUCKLEY, M.C., managing director of Metro-Cutanit, Ltd., Grappenhall, Warrington, died recently.

COMPANY		Denom.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	1/3
Allen (Edgar) & Co., Ltd.	Ord.	£1	38/-xd
" " "	5% Prf.	£1	14/6*
Arnott & Harrison, Ltd.	Ord.	4/-	13/6
Asquith Machine Tool Corp., Ltd.	Ord.	5/-	11/6
" " "	6% Cum. Prf.	£1	18/9
Birmingham Small Arms Co., Ltd.	Ord.	10/-†	40/6
" " "	5% Cum. "A" Prf.	£1	14/6
" " "	6% Cum. "B" Prf.	£1	17/6
" " "	4% 1st Mort. Deb.	Stk.	90½
British Oxygen Co., Ltd.	Ord.	5/-	26/6xd
" " "	6% Cum. Prf.	£1	20/-
Brooke Tool Manufacturing Co., Ltd.	Ord.	5 -	6/6
Broom & Wade, Ltd.	Ord.	5/-	22/3
" " "	6% Cum. Prf.	£1	18/9
Brown (David) Corporation, Ltd.	5½% Cum. Prf.	£1	16/-
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	18/-
Butler Machine Tool Co., Ltd.	Ord.	5 -	17/6
" " "	5% Cum. Prf.	£1	14/3
Churchill (Charles) & Co., Ltd.	Ord.	2/-	7/7½
" " "	6% Cum. Prf.	£1	25/9‡
Churchill Machine Tool Co., Ltd.	Ord.	5/-	39/6
" " "	6% Cum. Prf.	£1	18/-
Clarkson (Engrs.), Ltd.	Ord.	5/-	28/9
Cohen (George), 600 Group, Ltd.	Ord.	5/-	12/6
" " "	4½% Cum. Prf.	£1	13/-
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	24/-xd
" " "	5% Cum. Red. Prf.	£1	16/3
Craven Bros. (Manchester), Ltd.	Ord.	5/-	9/10½
Elliott (B.) & Co., Ltd.	Ord.	1/-	2/7½
" "	4½% Red. Cum. Prf.	£1	13/-
Expert Tool & Case Hardening Co., Ltd.	Ord.	2/-	2/-
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	11/6
Greenwood & Batley, Ltd.	Ord.	10/-†	26/3
Harper (John) & Co., Ltd.	Ord.	5/-	8/1½
" "	4½% Red. Cum. Prf.	£1	12/3
Herbert (Alfred), Ltd.	Ord.	£1	56/3
Holroyd (John) & Co., Ltd.	"A" Ord.	5/-	16/3
" " "	"B" Ord.	5/-	13/9
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	31/3
" " "	7% Cum. Prf.	5/-	5/-
Kearney & Trecker-C.V.A., Ltd.	5½% Red. Cum. Prf.	£1	11/-
" "	Prefd. Ord.	£1	13/9
Kearns (H. W.) & Co., Ltd.	Ord.	5/-	17/6
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	9/6
Macreadys Metal Co., Ltd.	Ord.	5/-	15/-
Martin Bros. (Machinery), Ltd.	Ord.	2/-	2/-
Massey (B. & S.), Ltd.	Ord.	5/-	10/-
Newall Engineering Co., Ltd.	Ord.	2/-	6/3
Newman Industries, Ltd.	Ord.	2/-	5/3
" " "	6% Prf. Ord.	5/-	5/-xd
Noble & Lund, Ltd.	Ord.	2/-	4/-
Norton, W. E. (Holdings), Ltd.	Ord.	2/-	3/3
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	43/-
" " "	5½% Cum. Prf.	£1	25/-
Pratt (F.) & Co., Ltd.	Ord.	5/-	14/9xd
Sanderson Kayser, Ltd.	Ord.	10/-	34/4½
" " "	6½% Cum. Prf.	£1	18/-
Scottish Machine Tool Corporation Ltd.	Ord.	4/-	10/-
Shardlow (Ambrose) & Co., Ltd.	Ord.	£1	45/-
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	16/3
Sheffield Twist Drill & Steel Co., Ltd.	Ord.	4/-	15/6
" " " "	5% Cum. Prf.	£1	14/3
Stedall & Co., Ltd.	Ord.	5/-	7/6
Sykes (W. E.), Ltd.	"B" non-voting Ord.	10/-	24/-
Tap & Die Corporation, Ltd.	Ord.	5/-	14/6
" " "	4½% Deb. 1961-1977	Stk.	84½
Wadkin, Ltd.	Ord.	10/-	18/9
Ward (Thos. W.), Ltd.	Ord.	£1	66/-
" "	5% Cum. 1st Pref.	£1	14/6
" "	5% Cum. 2nd Pref.	£1	23/-
Willson Lathes, Ltd.	Ord.	1/-	3/4½

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. † Ordinary £1 shares have been subdivided and are now Ordinary 10/- units. ‡ Birmingham price.

PRICES OF MATERIALS

All prices per ton except where otherwise stated.

Pig Iron

Foundry and Forge No. 3, Class 2

Middlesbrough (10 tons or over)	£21 17 0
Birmingham (10 tons or over)	£21 9 3

Phos. Over 0·1 up to 0·4%

Birmingham (6 ton lots)	£23 5 0
Grangemouth (6 ton lots)	£23 10 0

Hæmatite

English No. 1 (10 tons or over)	
N.E. Coast (made in N.E.)	£23 19 0
Scotland	£24 5 6
Sheffield	£25 9 0
Birmingham	£25 13 0
Welsh 10 tons or over	£23 19 0

Steel Products

Medium plates (50 tons andover)	£43 16 6
Mild steel plates, ordinary (50 tons and over)	£40 7 0
Boiler plates (50 tons and over)	£42 17 0
Flat bars, 5 in. wide and under (50 tons or over)	£39 1 0
Round bars, under 3 in. (50 tons or over)	£39 1 0
Billets, rolling quality, soft U.T. (100 tons or over)	£31 15 6

Phosphor Bronze

Ingots (288) (A.I.D. d/d	£306 0 0

Copper

Cash (mean)	£219 12 6
Cold rolled and hot rolled sheets 4 ft. by 2 ft. by 10 SWG	£296 15 0—297 0 0
Rods, $\frac{7}{16}$ in. to $\frac{1}{2}$ in. diam.	£314 0 0
Tubes, $1\frac{1}{2}$ in. bore by 10 SWG, ton lots, per lb.	3s. 0½d.
Wire rod, black, hot-rolled ($\frac{1}{4}$–$\frac{7}{16}$ in.), English	£235 2 6

Zinc

Refined, minimum 98 per cent purity, current month (mean)	£79 2 6

Brass

Tubes, solid drawn, per lb.	1s. 9d.
Strip 63/37, 6in. by 10 SWG coils, ton lots	£252 0 0—£255 0 0
Rods, $\frac{1}{2}$–3 in. diam. (59 per cent copper)	2s. 0d.

Yellow Metal

Condenser plates, per ton	£179 0 0
Rods, per lb.	2s. 1d.

Aluminium

Ingots, min. 99·5 per cent Canadian d/d	£186 0 0

Tinplates

*U.K. Home trade: Cold reduced, f.o.r. makers works (15-50 tons)	£3 6 8
U.K. Export: Hot rolled basis, f.o.r. works port	73s. 6d.—76s. 0d.
Cold reduced basis, f.o.r. works port	73s. 6d.—76s. 0d.

Gunmetal

Ingots, B.S. 1400 L.G.2, delivered	£213 0 0

* Official maximum price, after allowing for adjustments for increase in price of tin.

MAKERS' PRICES

Hexagon Steel Bars[1]

Sizes in inches from 1 in. up to 2·21 and 2·41 a/f ex works, 2 ton basis	£42 17 0
Free cutting black	£47 6 6

Reeled Steel Bars[1]

Single-reeled, 1½ in. upwards, f.o.t. works (+ usual extra for sizes)	£43 9 6
Free cutting	£47 19 0

Precision-ground Mild Steel[2]

1-in. diam. + 0·00025-in. 4-ton lots, per cwt.	121s. 6d.

Bright Ground Stainless Steel Bars[3]

EN56AM (martensitic, free cutting)	£304 10 0
EN58AM (austenitic free cutting)	£377 10 0

Prices are basic, subject to extras

High-speed Steel

Black random length bar. All prices basic, per lb., subject to extras:

Molybdenum "66"	6s. 5d.
Molybdenum "46"	6s. 3d.
14 per cent tungsten	6s. 11d.
16 per cent tungsten	7s. 4d.
18 per cent tungsten	7s. 9d.
22 per cent tungsten	9s. 2d.
5 per cent cobalt	10s. 10d.
4·75/5·25 molybdenum + 6·0/6·75 tungsten + 1·75/2·05 vanadium per cent (5-6-2)	6s. 7d.

Precision-ground, High-speed Free-turning Brass Rod[3]

½-in. diam. ±0·00025-in., 2 ton lots, per lb.	2s. 9½d.

Grey Iron Rod

Die*Cast[4] in random lengths 18 in. to 26 in. rough machined $\frac{1}{16}$-in. above listed size. Extra for definite lengths. Discounts for orders over £150.

	Per cwt. net. Mark I	Mark III
¼ or ⅜ in.	252s. 8d.	328s. 5d.
1 or 1¼ in.	201s. 3d.	259s. 5d.
1½ to 1¾ in.	142s. 0d.	176s. 4d.
1⅞ to 2 in.	109s. 4d.	129s. 8d.
2¼ to 3½ in.	94s. 3d.	109s. 6d.
3¾ to 12 in.	89s. 1d.	102s. 2d.

Continuous Cast

10-ft. lengths, centreless machined 1 to 3-in. diam. + 0·010 to 0·020 in., prices as quoted for die cast bar[4]

centreless ground 1 or 1¼ in. +0·010 in. Extra	202s. 3d.
for hardenable alloy iron[5]	1½ to 1¾ in. 142s. 0d.
	1⅞in. to 2 in. 109s. 4d.
Per cwt. net	2¼ to 3½ in. 94s. 3d.

Stellite[6]

Welding Rods, plain

¼ in. diam., per lb.	30s. 0d.

Toolbits

½ in. sq. × 4 in., each	22s. 3d.

1 Colvilles, Ltd., Glasgow, and 17 Grosvenor Street, London, W.1. 2 Pratt, Levick & Co., Ltd., Chester. 3 Spartan Steel & Alloys, Ltd., St. Stephens Street, Birmingham, 6. 4 Sheepbridge Alloy Castings, Ltd., Sutton-in-Ashfield. 5 "Flocast," Harold Andrews Sheepbridge, Ltd., Halesowen. 6 Deloro Stellite, Ltd., Highlands Road, Shirley, Solihull.

BASIC PRICES FROM LONDON STOCK[1]

Free Cutting Steel

Bright cold drawn: (Usaspead) over 1 to 2 in.	£59 4 6
Lead bearing (Usaled)	£63 11 0
Precision ground, 1⅛ in.	£81 4 6

Bright Drawn

M.S. bars (M.M.C.) over 1¼ to 2 in.	£56 10 0
Square edge flats (Usaflat)	£73 6 6
M.S. angles (Usaspead)	£100 6 6
Case hardening (EN) (Usacase) over 1½ to 2 in.	£62 10 0
M.S. bars (EN3B) (Usamild) over 1¼ to 2 in.	£58 16 6
Carbon manganese semi-free cutting case hardening (EN202) (Usaspead 202) over 1½ to 2 in.	£71 5 0
35/45 ton tensile (EN6) (Usen) over 1 to 1¼ in.	£67 3 0
0·4 carbon normalized (Usaspead "40") over 1½ to 2 in.	£69 5 0
0·45 carbon normalized EN9 (Usaspead 55)	£69 15 0
Carbon manganese steel to Specification EN16T (Usaspead 5565), per ton	£126 17 0

Ground Flat Stock

18-, 24-, and 36-in. lengths (Usaspead). List prices plus 5 per cent, less 5 per cent.

Oil Hardening Cast Steel

Non-shrink (Usaspead N.S.O.H.) ¾ in. to 2½ in., per lb.	1s. 11d.
Non-distorting heavy duty (Usaspead H.C.H.C.), ¾ in. to 2½ in., per lb.	4s. 2d.

Silver Steel

(0·194-in. to 1½-in.) Genuine Stubs quality, per lb.	4s. 6d. + 5% less 27½%
M.M.C. quality, per lb.	2s. 7d. + 6½%
Boxes of 16 assorted sizes, $\frac{7}{16}$ in. to ¾ in. diam.	7s. 6d.

Stainless Steel

KE40AM (free cutting), per lb.	3s. 8d.

Glacier Machined Bronze Bars

Phosphor bronze (288) / Lead bronze	Prices on application

High-speed Steel

18 per cent tungsten. Prices on application.

Toolholder bits:

Usaspead "Super" / "Supreme" / Cobalt 10	List price

Shimstock

Steel assorted, per tin	3s. 6d.
Brass " "	7s. 3d.

6 Macready's Metal Co., Ltd., Pentonville Road, N.1. Subject to confirmation by London Office. Delivered free by van in London area.

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SCHULER

MASSEY

BRITISH-BUILT FRICTION SCREW PRESSES FOR COLD AND HOT WORKING

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Capacities:

Machine ...	6	10	12A	16	20A
Zinc lbs. ...	¾	2¾	6.3	13.6	25.7
Alum lbs. ...	—	1½	2.1	4.5	—
Max. die ...	8½ × 9¼	16 × 10	20 × 12½	28½ × 16¼	35½ × 19¼
Platen stroke ..	4½	6	8	11	13

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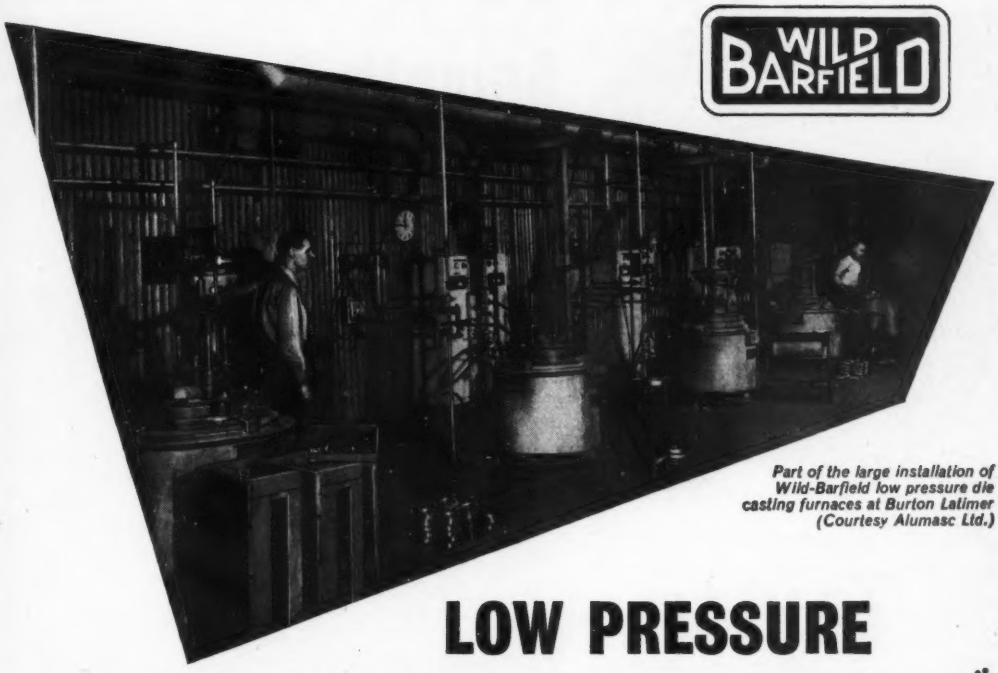

Part of the large installation of Wild-Barfield low pressure die casting furnaces at Burton Latimer (Courtesy Alumasc Ltd.)

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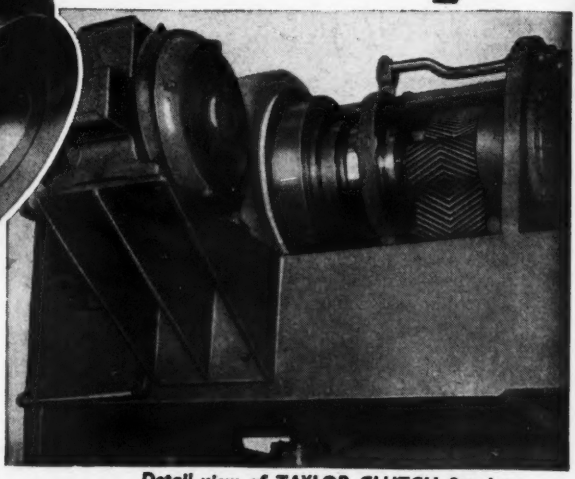

Detail view of TAYLOR CLUTCH fitted to fly wheel on Press Brake

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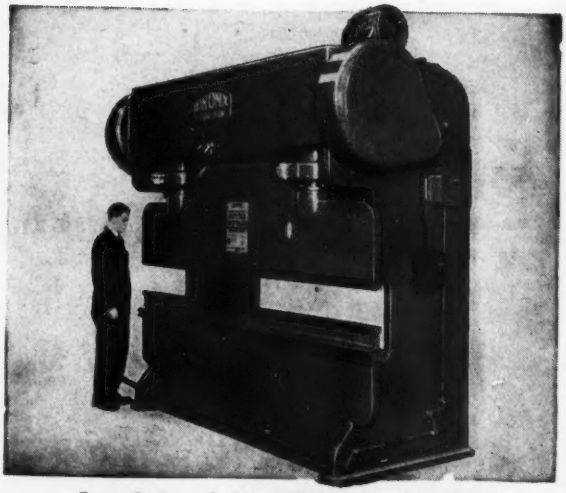

General view of above, 150 ton by 12 ft. PRESS BRAKE.

Photograph by courtesy of The Bronx Engineering Co. Ltd., Lye, Nr. Stourbridge, Worcs.

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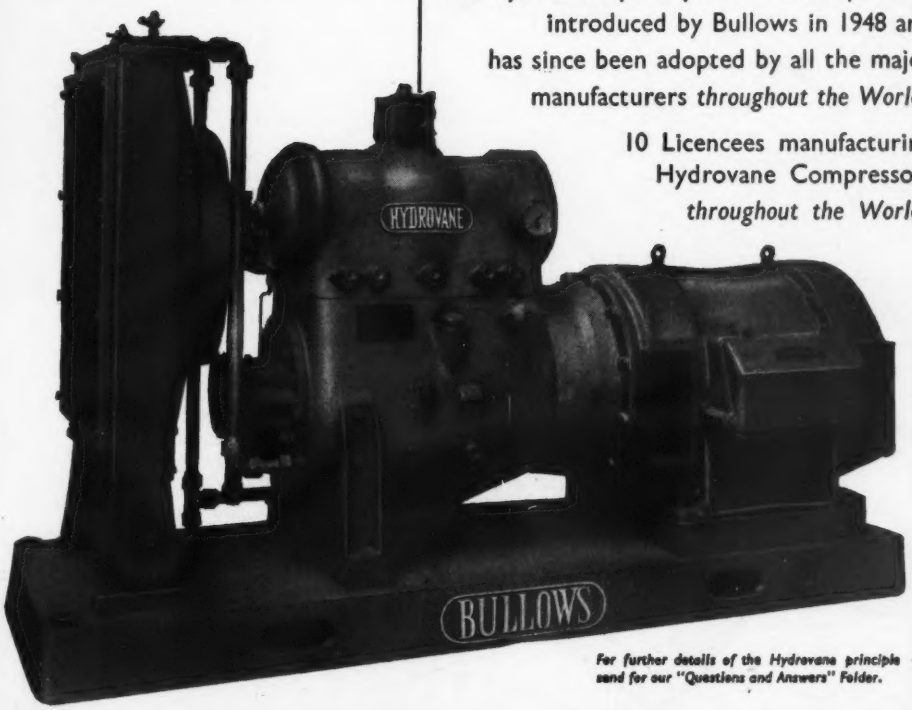

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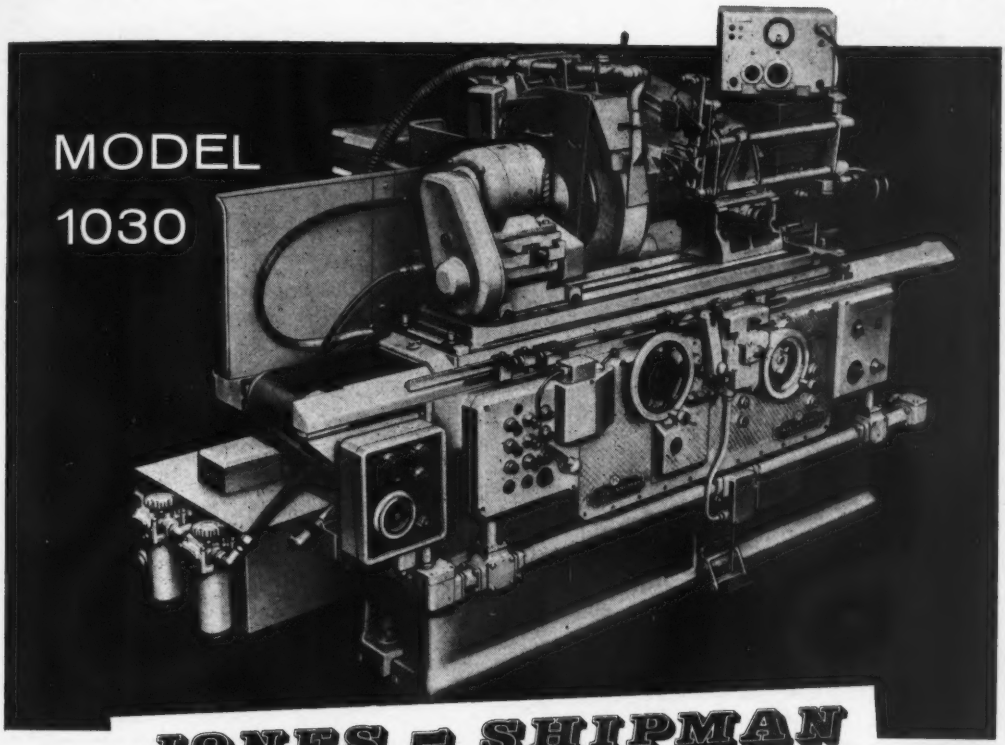

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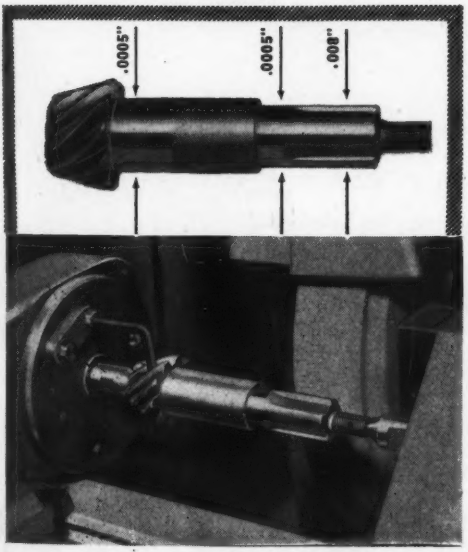

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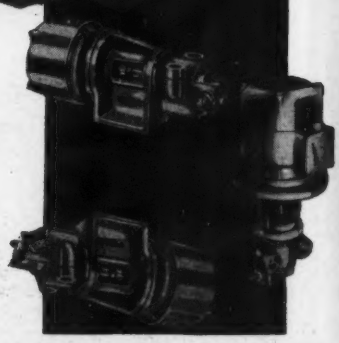

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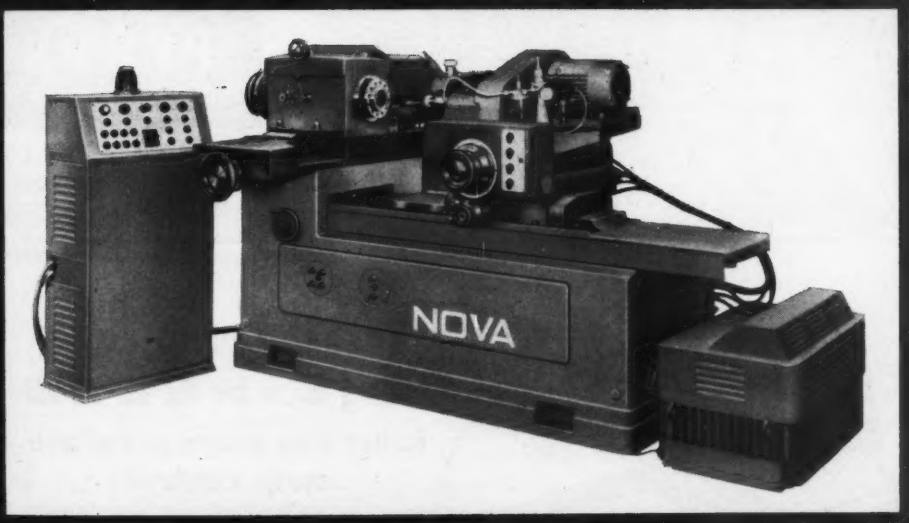

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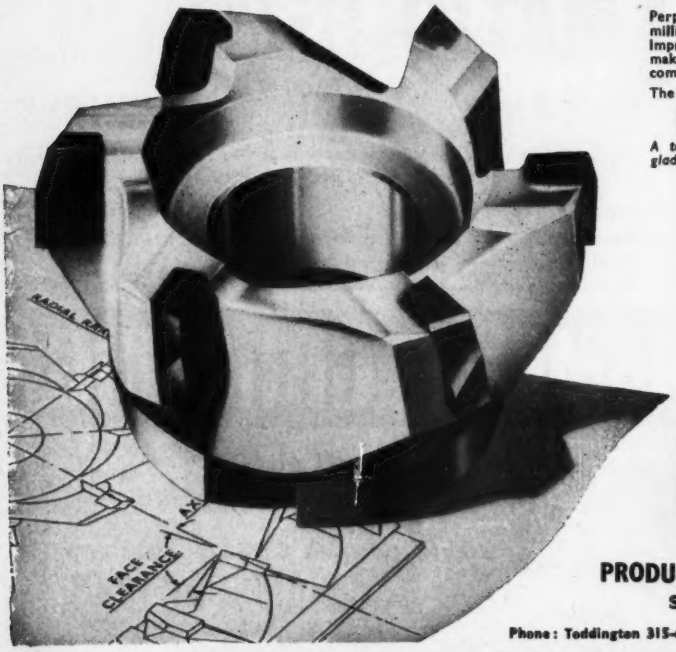

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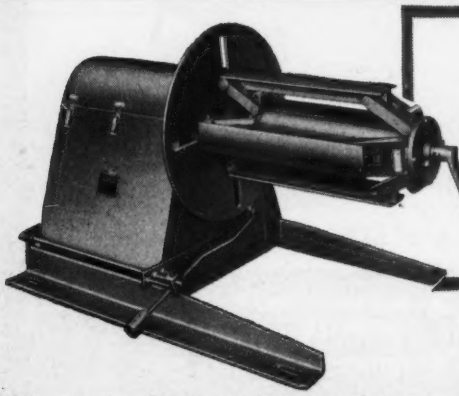

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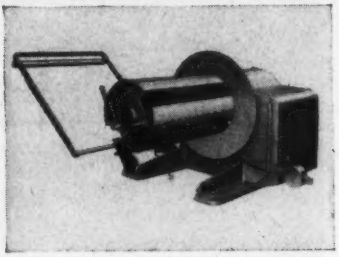

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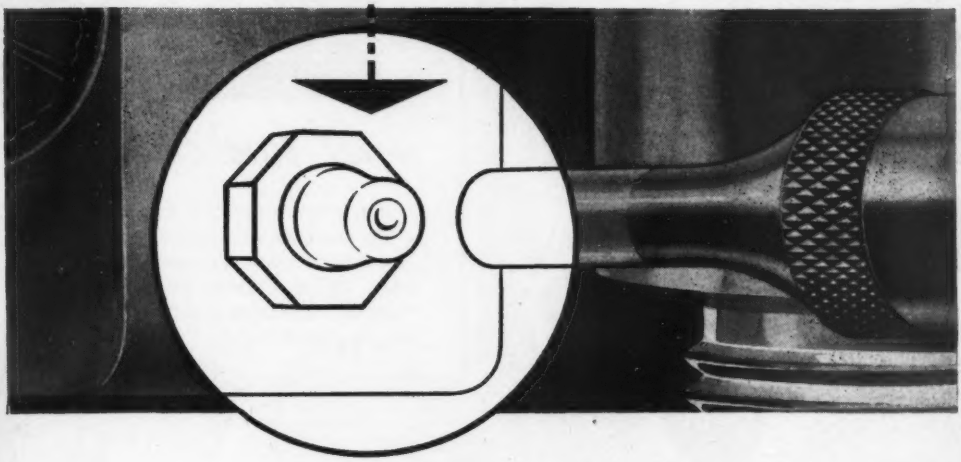

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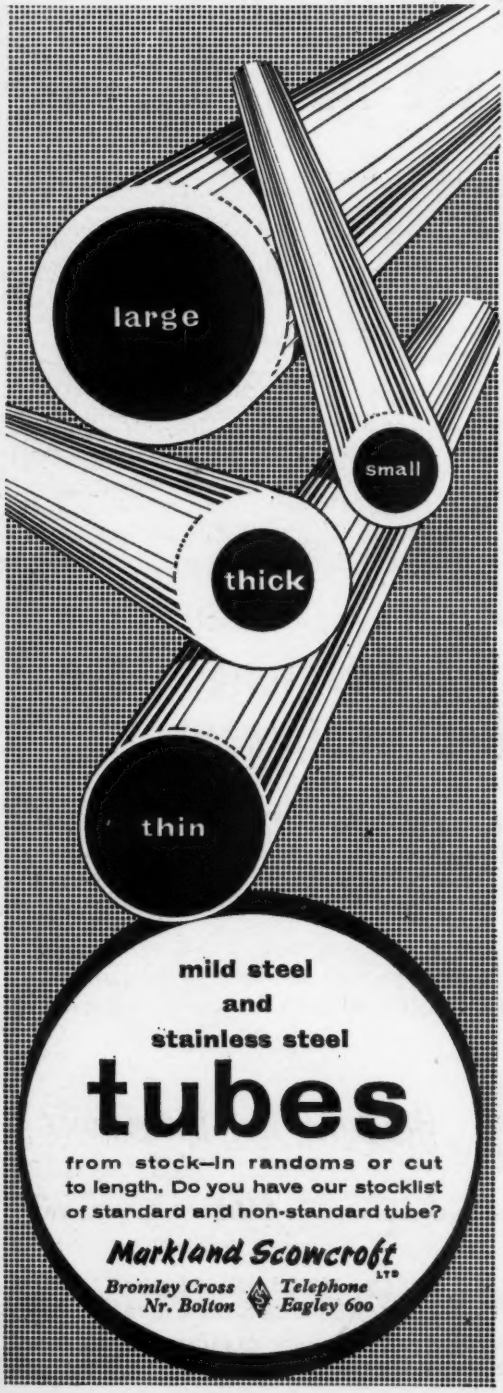

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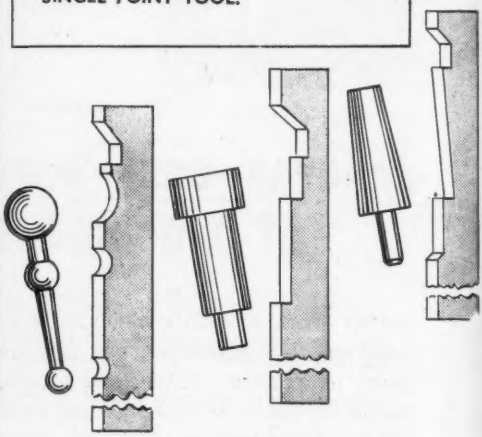

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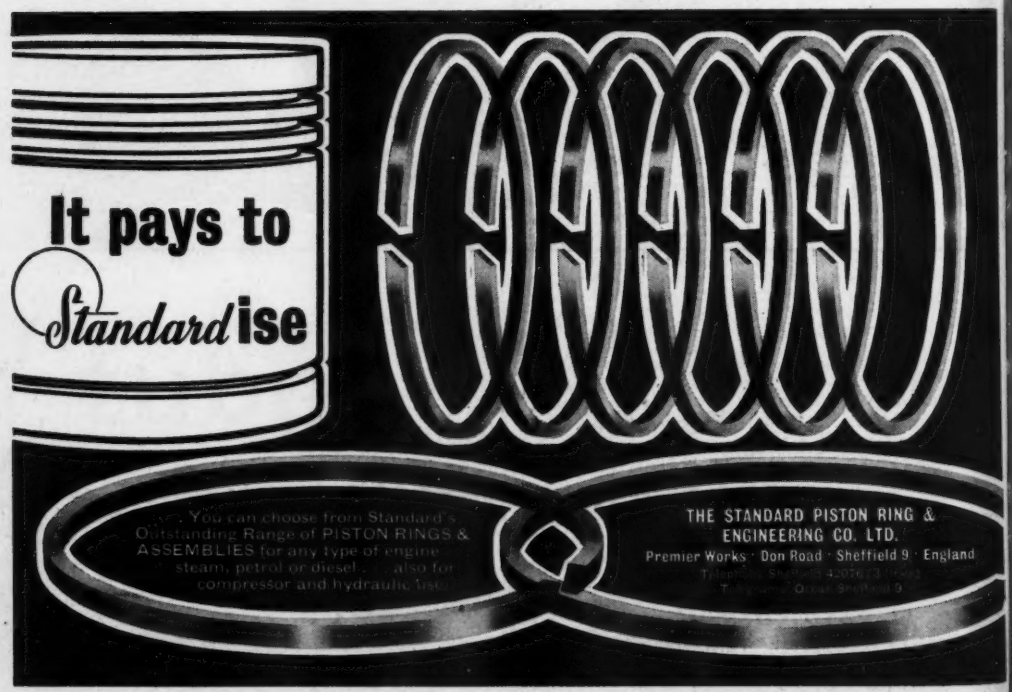
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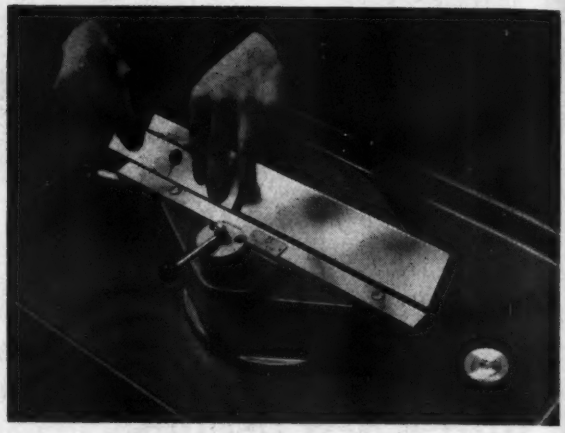

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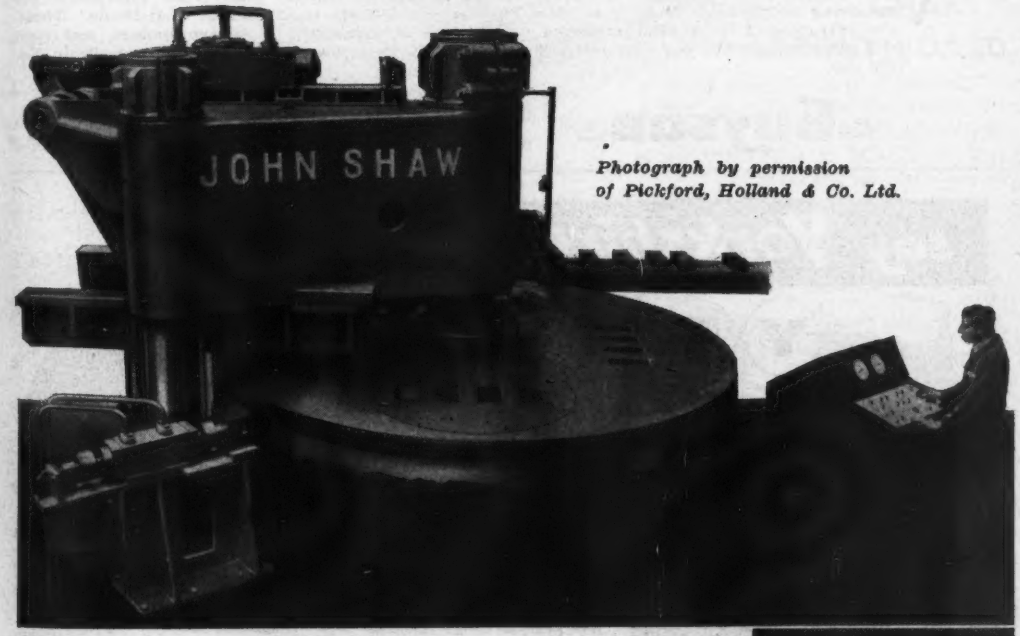

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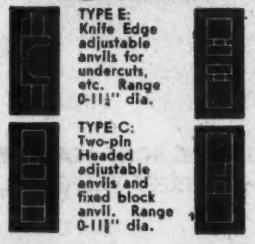

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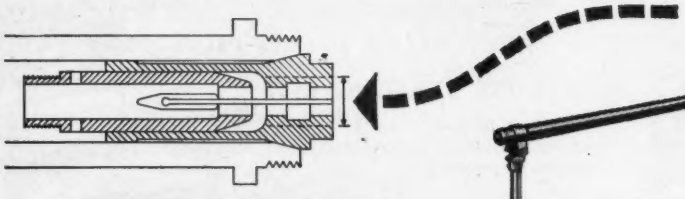

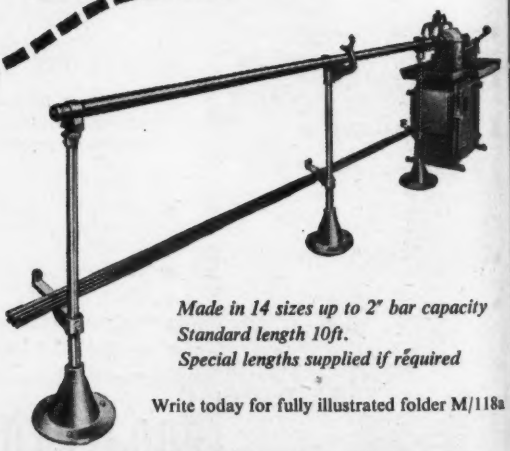

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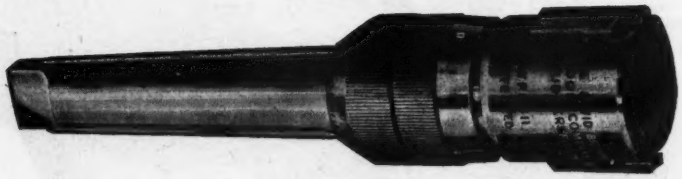

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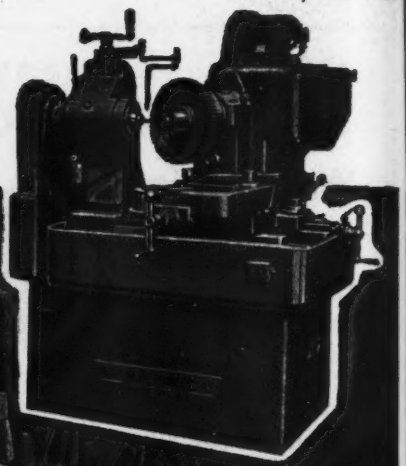

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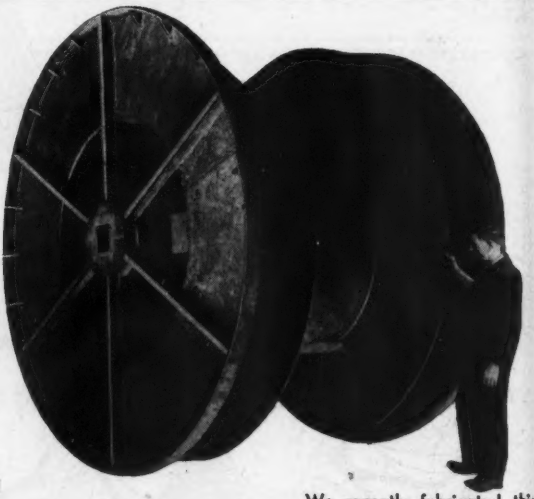

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Photo by courtesy of ARTHUR SCRIVENER Ltd., B'ham.

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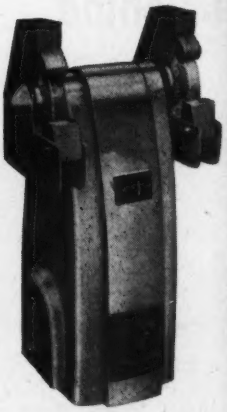

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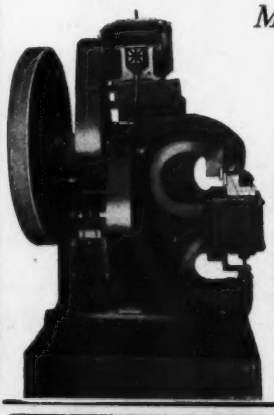

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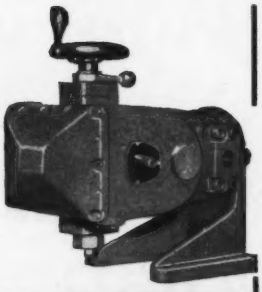

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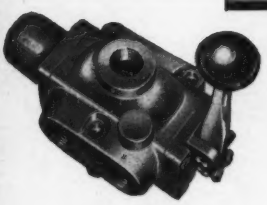

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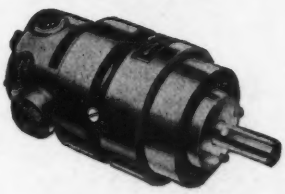

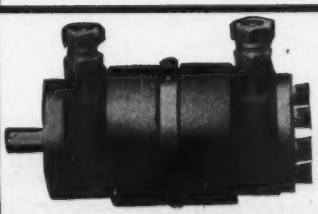

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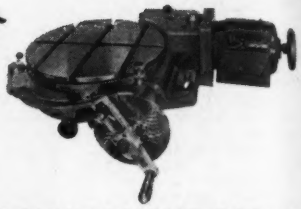

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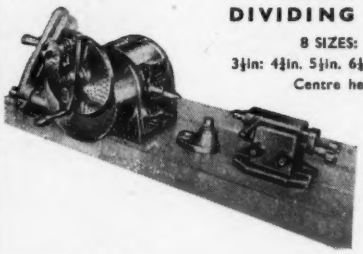

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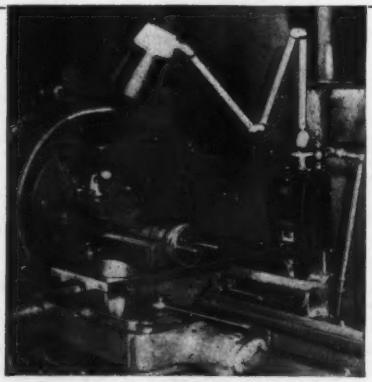

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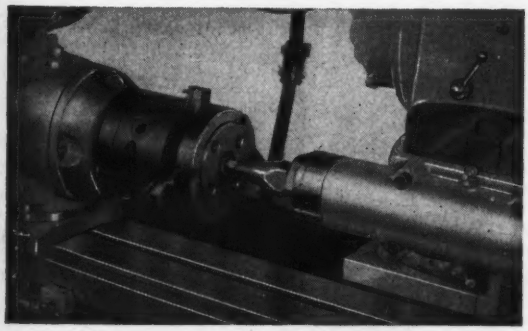
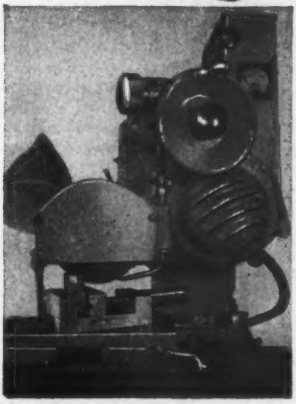


The machine can be rapidly adapted for internal grinding as shown.



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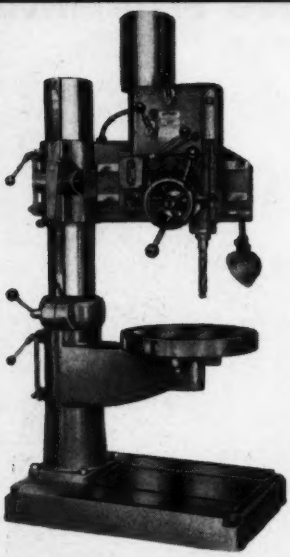

Illustrated is model ER 1830, 24in. radial, 8 speeds, 2 feeds, cap. 1¼in. Price £446.

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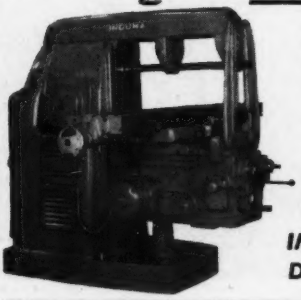

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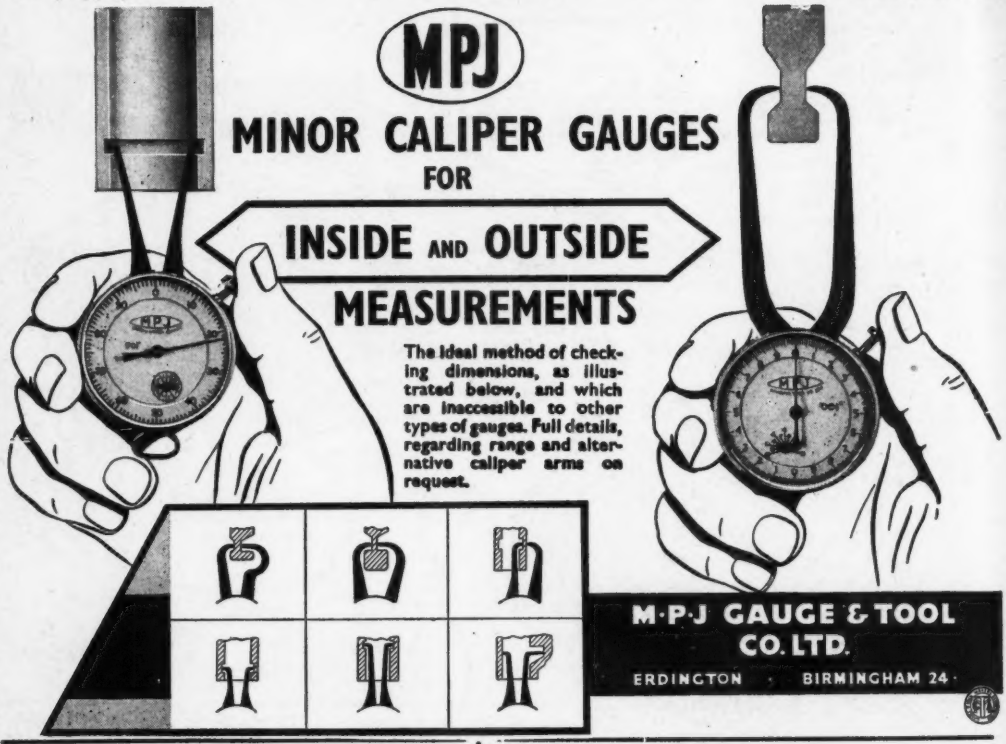

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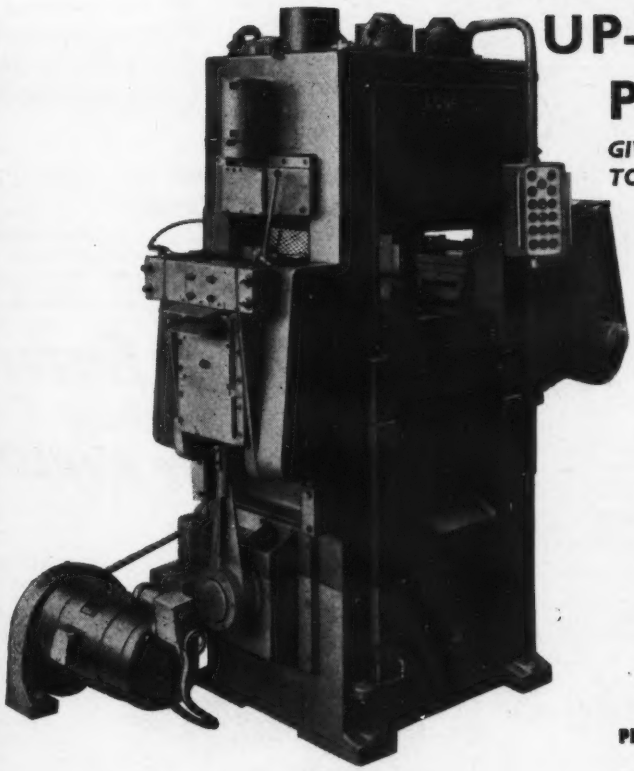

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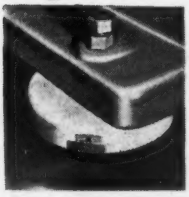

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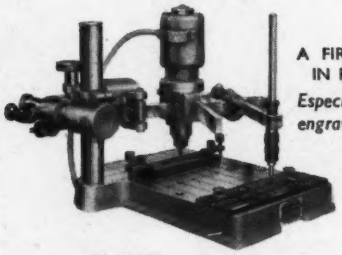

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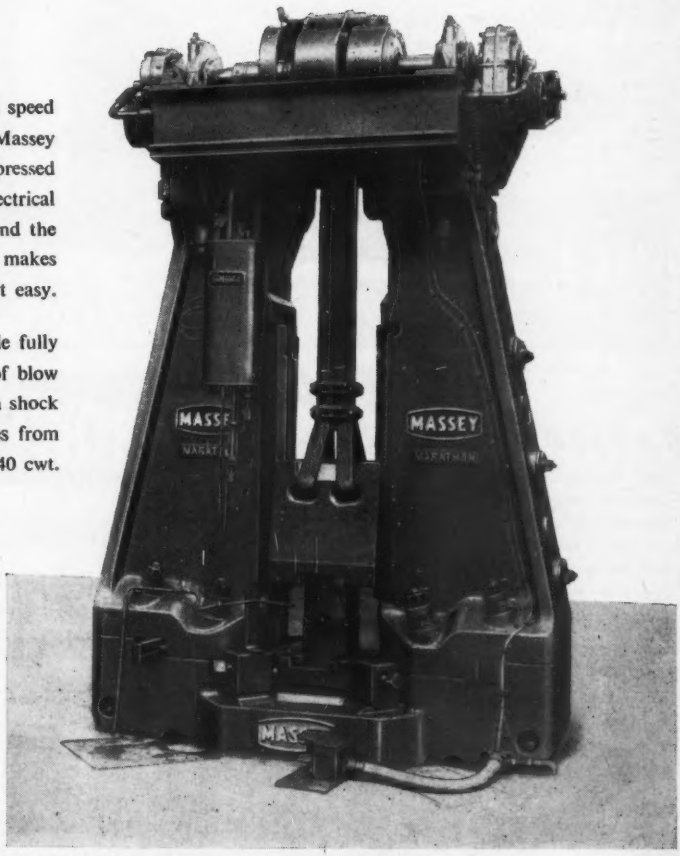

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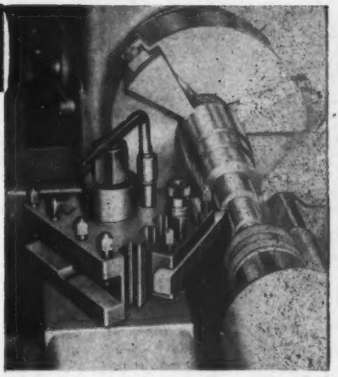

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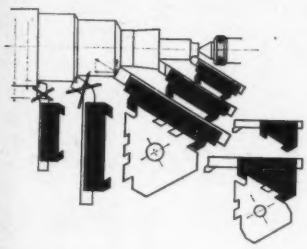

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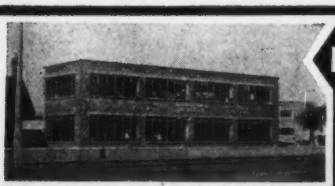

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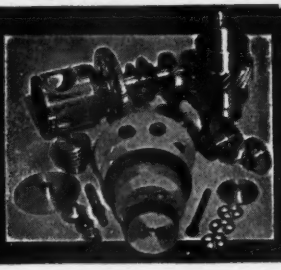

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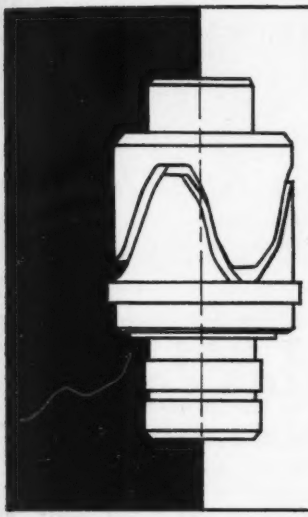

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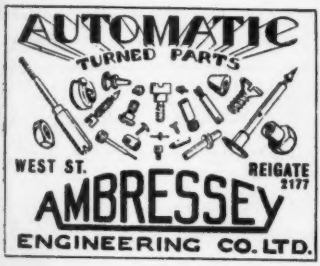

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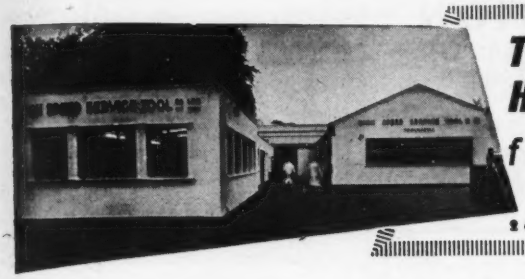

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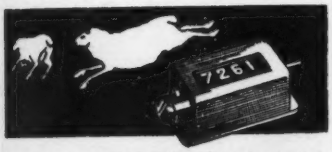

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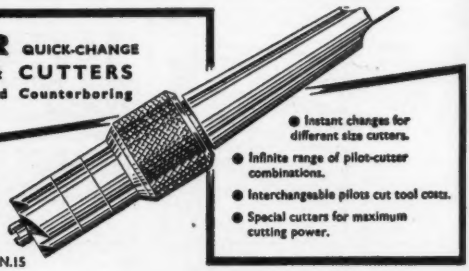

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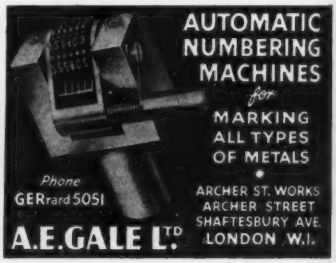

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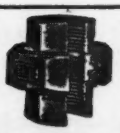

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CHURCHILL 10in. × 24in. Universal.
LANDIS 12 × 48 Universal.
BROWN & SHARPE No. 3 Universal.
NORTON 14in. × 36in. Universal.
ROWLAND Three Wheel Carbide Tool Grinder and Lapper.
NEWALL 10U Universal Lapper.

CAPSTAN AND TURRET LATHES

MURAD 3Q, ¾in. collet capacity.
MOREY 2G, 1in. collet capacity.
GISHOLT IL Turret Lathe.
FOSTER No. 28 Turret Lathe.

CENTRE LATHES

LODGE & SHIPLEY 12in. Swing.
WILLSON 7¼in. Newel.
ROLLO SUPREME 7¼in.
WARD, HAGGAS & SMITH 8¼in. Gap Bed, 36in. between centres.
CROMWELL 3½in. Precision.

MILLERS

KENT OWENS 1-8 and 1-14 Horz. Hydraulic.
SUNDSTRAND No. 0 Rigidmill.
ARCHDALE 14in. Horizontal.
GRAFFENSTADEN FH12I Plain Horizontal with Universal Vertical Head. Table size 59in. × 13¾in.
MATTERSON No. 1 Thread.
REIDEN No. 2 Vertical. 1953 machine.
HERBERT 23V Vert. Table 68in. × 17in. 48in. traverse.
REED PRENTICE No. 6 Heavy Duty Vert. Table 84in. × 20in. 72in. traverse.
HOLROYD T117 Thread Miller.
HELLER Automatic Thread Millers (4).
MOREY 12M Duplex Profiler.
ASQUITH HKO Duplex Keyseater.

PRESS

V & O No. 11 Double Action. Approx. 10 tons. Tool feed. Max. draw 1in.

All machines motorised 400/3/50 unless otherwise stated.

Two—**2A WARD** Capstan Lathes with Bar Feed.

DIMCO (Gt. Britain) LTD.
28, Wood Lane, SHEPHERD'S BUSH, LONDON, W.12.
SHEpherd's Bush 4401/2.

"E.M.B." No. 16 Airdraulic 4-column Universal Mandrel Press for sale. Pressure exerted 7 tons. Between columns 18¼in. Diameter of piston 16in. Maximum length of stroke 8in. Revolving table 13¼in. diameter with four openings. Maximum daylight 15in. Diameter of ram 4in.—F. J. EDWARDS LIMITED, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham 3.

FELLOWS Model 61A Gear Shaping Machine. 18in. capacity.
BARBER COLMAN No. 12 Gear Cutter. Capacity 15in. × 15in. Hollow spindle 1¼in. dia.
ARCHDALE 20in. Plain Horizontal Milling Machine. Double overarm. Table 44in. × 10in.
MILLS 80-ton Oilaulic Vertical Straightening Press. Table 108in. × 20¼in. Stroke 12in.
ARCHDALE Heavy Duty Column Drilling Machine. Speeds 6 to 265 r.p.m. No. 5 Morse Taper.
TAYLOR & CHALLEN Model 370—20-ton open-fronted, ungeared, Power Press. 3in. stroke.
WARNER & SWASEY ¼in. capacity Capstans. Collet head. Lever feed cross slide and turret.
WICKMAN 8in. Grinding and Diamond Lapping Machine. Tilting table 25in. × 16in.

PARKES (MACHINE TOOLS) LTD.
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Tel.: EASt 1742

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COLCHESTER "MASCOT" 8¼in. Lathe.
COLCHESTER "STUDENT" 6in. × 24in. Lathe.
VICTORIA U2 Universal Miller
SENIOR M1 Horizontal Miller.
MYFORD MG12 5in. × 12in. Cylindrical Grinder.
RICHMOND HB3/13 4ft. 6in. Radial Drill.
RICHMOND SR 2 36in. Radial Drill.

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KEIGHLEY UNIVERSAL GRINDER

Type KU. 12in. by 24in. with all equipment. Machine which is in excellent condition has had five years' careful use on toolroom work. Can be seen working by appointment.

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No. 16 HYPOID GENERATORS

Arranged for finishing Spiral Hypoid or Zerol Bevel Gears. **£2,890** ea.

MAXICUT No. 2 High Speed GEAR SHAPERS, in excellent condition. **£275** each.

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Phone for appointment.

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QUALITY MACHINE TOOLS for
PLANING & SLOTTING IN STOCK

PLANERS

20ft. by 15ft. LOUDON Hor. and Vert. Planer (wall type), horz. stroke 20ft., vert. stroke 15ft., A.C./D.C. gen. set. drive.

5ft. 9in. by 4ft. 11in. by 13ft. 2in. BILLETER & KLUNZ Double Column Planer. Type NDC/IT. 4000 with two tool heads on crossrail and one on each upright. Heid-Vulkan electro-magnet Reversing Clutch drive and 9-speed gearbox.

4ft. by 4ft. by 8ft. SWIFT SUMMERSKILL Size 48M Double Column Planer, 2 toolheads on crossrail and one sidehead, Ward-Leonard drive.

3ft. 6in. by 3ft. 6in. by 15ft. BUTLER Double Column Planer, size No. 4, 2 toolheads on crossrail and 2 sideheads, A.C./D.C. gen. set drive, pendant control, table width 3ft.

3ft. 1in. by 2ft. 7in. by 9ft. 10in. WALDRICH Openside Hydraulic Planer, 2 toolheads on crossrail and one sidehead, all electric drive.

SLOTTERS

36in. ROCKFORD Hy-Draulic, table dia. 42in., admits in dia. 83in., height under ram housing 39in.

20in. MINGANTI, Type SM500 1952, with tilting ram.

16in. BETTS-BRIDGFORD Heavy Duty, table dia. 34in., admits in dia. 70in., h.p. motor 7½.

14in. BUTLER High Production, table dia. 39in., admits in dia. 60in., h.p. motor 12½.

8in. ORMEROD High Speed, table dia. 18in., admits in dia. 30in., h.p. motor 4, rebuilt.

All machines motorised 400 volts, 3-phase, 50 cycles.

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SOAG MACHINE TOOLS LTD

S.O.A.G

ASQUITH Two-Spindle Profile Milling Machine, independent motor drive to each spindle, 415/3/50, table W.S. 18in. × 15in. Range of speeds 250 to 3,000 r.p.m.

ARCHDALE Swivel Head Vertical Milling Machine, 415/3/50. Table W.S. 36in. × 10in.

TRIDENT Model V.O. Swivel Head Vertical Milling Machine, 415/3/50. Table W.S. 30in. × 8in.

R. O. Gray.

4/6, Minerva Road, Park Royal, London, N.W.10

Telephone: ELGar 4841/4842

Dean, Smith & Grace 10in. × 40in. between Centres S.S. & S.C. Lathe Serial No. 23202. Built-in flange type motor Completely rebuilt.

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Nearly New (1955)

SWIFT SUMMERSKILL

6ft. × 3ft. × 3ft. all Electric Planing Machine. 3 toolboxes.

F. J. EDWARDS LTD.,

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Telephone: EUSTON 5000. Telex 24264.

Bryant No. 24-36 Hydraulic Internal Grinder complete with Hydraulic Wheel Dressing Device, Spindle, etc.

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Rebuilt Gisholt No. 3L Motorised Geared Head Turret Lathe, as new, and equipment.

Brown & Sharpe No. 2 Motorised Universal Grinder, and equipment.

Jones & Shipman 6in. × 12in. Tool and Cutter Grinder.

Planer, 24in. × 24in., with 6ft. table.

Also other Machine Tools, Plant and Small Tools for immediate sale.

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Radius Turning Attachment suitable for attaching to small precision lathes for turning internal and external radii to ¼in. accuracy of ±.0002in.—BOX C527, MACHINERY, Clifton House, Euston Road, N.W.1.

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HARVEY (S.M.T.C.) Heavy Duty Lathe, S.S. & S.C. 18in. centres by 9ft. 6in. b.c. 29in. swing over saddle. Ball and Roller bearing spindle, 12 speeds 8.6/225 r.p.m. Rapid traverse to saddle. 32in. chuck. 15 H.P. motor 400/3/50. £2,250.

BOX C.537, MACHINERY,
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FORD AND SLATER LIMITED,

MOTOR ENGINEERS,
GWENDOLEN ROAD,
LEICESTER,

have the following machines for disposal, all in first class working condition:—

ONE **CHURCHILL** Type DE Crankshaft Regrinding Machine, 30in. × 120in. Fitted with Phillips Magnetic Clarifier.

ONE **CHURCHILL** Type CY Grinding Machine, 18in. × 48in. Fitted with Phillips Magnetic Clarifier. Complete with 4-jaw chucks.

ONE **KITCHEN & WADE** Honing Machine. Fitted with George Alexander honing heads, 2.20in.-6.00in. dia. capacity.

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PEARN-RICHARDS PRT2N Horizontal Boring and Facing Machine. 3in. Traversing spindle, chain drive to head, coolant fittings, 400/3/50. As New.
SONDERMANN & STIER 8ft. Double Column Heavy Duty Vertical Boring and Turning Mill, with side head, swing 104in. dia., admit 58in. high table to cross slide, 35 h.p. motor.
PENSOTTI KTV.1050 Turret Type Vertical Boring and Turning Mill, with side head, swing 43in. dia., table speeds 10 to 125 r.p.m.
WEBSTER & BENNETT 48in. Single Column Turret Type Vertical Boring and Turning Mill, to swing 104in. dia. Taper Turning Attachment, 35 h.p. motor.
ASQUITH OD.1 4ft. Radial Drilling Machine, No. 5 Morse Taper.
GORTON Model 3.U High Precision Two-dimensional Pantograph Engraving Machine, longitudinal feed 10in., vertical feed 9¼in. max. Work table 8in. × 12in. Ratios 1 : 1 to 1 : 40. Useful quantity of copy in fitted wooden boxes.
REINECKER 10ft. Automatic Gear Shaping Machine. Face width 7in., max. pitch 1 d.p.
KLINGELNBERG HK.500B 20in. Capacity Gear Quenching Press.
NORTON Model "C" 14in. × 36in. Hydraulic Universal Cylindrical Grinding Machine. Excellent equipment including internal spindle.
CHURCHILL Model PBH 12in. × 36in. Hydraulic Universal Cylindrical Grinding Machine. Excellent equipment, including internal spindle, steadies, etc.
DO-ALL Horizontal Spindle Hydraulic Surface Grinding Machine, capacity 16in. × 6in., wheel 7in. × 1in.
SNOW Model T.20 Table Type Surface Grinding Machine, with extended table, dust extractor, etc. Three machines available. In excellent condition.
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HERBERT No. 7A Combination Turret Lathe, covered prismatic bed, 15¼in. swing, speeds 30 to 750 r.p.m. 400/3/50.
MINGANTI 20-40P Hydraulic Pre-Selector Bar Feed Capstan Lathe, 14¼in. swing, 1¾in. collet chuck, speeds 60 to 1,500 r.p.m. 400/3/50.
WARD No. 3A Chucking Capstan Lathe, 13in. swing, 1¾in. hollow spindle, speeds 42 to 825 r.p.m. 400/3/50.
WARD No. 2A Bar Feed Capstan Lathe, 11in. swing, 1¼in. hollow spindle, speeds 48 to 1,020 r.p.m. 400/3/50.
GORTON 9J Duplicating and Diesinking Machine. Table working surface 35in. × 10¼in. Hand operated duplicator table.
CINCINNATI No. 4 Dial Type High-Speed Plain Horizontal Milling Machine, oversize table 86¼in. × 16¼in.
SOMUA FV.4B Vertical Milling Machine, table 75in. × 16in.
MILWAUKEE 3H Vertical Milling Machine. Table 75in. × 16in.

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CANAL STREET, NOTTINGHAM
'Phone: 51891

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Maximiller Vert. Mill, 76in. × 18in., 888 T/S. Power to spindle and rapid all ways. REBUILT.
Somua F.V.2C, 60in. × 14¼in. Vert. As new.
Herbert 18V Vert., 57in. × 14in. With rotary table. £525
Becker Vertical, 54in. × 14in. £150
Sant Andrea U.F.O.3, 57in. × 14in. As new.
Archdale 24in. Manufacturing. £185
Adams No. 5 Spline and Thread Hobber. £425

PRESSES AND SHEET METAL MACHINERY

Edwards 6ft. × ¼in. Rolls. New. £295
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CAPSTAN LATHES

Ward 2A. Feed to saddle.
Gisholt No. 3 Capstan. £275
Brown & Sharpe No. 2. 1in. cap. £145
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Smart & Brown ¼in. cap. Capstan.

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Willson 8¼in. × 4ft. 6in. S.S. & S.C. £495
Niles 40in. swing × 5ft. Heavy Duty. £995
Dean, Smith & Grace S.S. & S.C., 36in. swing, 12ft. 6in. between centres.
Ditto. Non-screwcutting.
Churchill-Redman 6½in. × 3ft. 6in. £325
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Acme Gridley 6-sp. Auto, ¾in. cap.
Maiden Bar-ending Machine.
Granor 26in. Heavy Duty Shaper. £575
Coventry Climax 1,500lb. Fork Lift Truck.
Cincinnati 12in. × 48in. Univ. Grinder. £750

Many other machines in stock.
All motorised 440/3/50.

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KEETONA Power Guillotine, 4ft. × 16 gauge, 400/3/50. £150.
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EDWARDS 12 Ton Adjustable Stroke Power Press, 400/3/50. £165.

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KEARNS No. 2 Horizontal Borer, Travelling Spindle.
PROGRESS 4E Pillar Drill.
WALLWORK 24in. Gear Hobber.
CHURCHILL Hcy Internal Grinder.
JONES & SHIPMAN 8in. × 12in. Semi-Universal Grinder.
HERBERT No. 4 Capstan Lathe.
HERBERT No. 7 Combination Turret Lathe.
STANLEY 8½in. × 48in. Lathe.
MODERN Horizontal Miller, 9in. × 40in.
ARCHDALE 28in. Plain Miller.
KENDALL & GENT 4in. Screwer.
CINCINNATI 4/36 Hydromatic Miller.
KENDALL & GENT No. 3 Vertical Miller, table 60in. × 21in.
HUNT No. 3 Twist Drill Grinder.
DENBIGH No. 2 Fly Presses.

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NEW H.M.V. 7S HORIZONTAL BORING Machine. 3in. travelling spindle, 18in. facing head, revolving table 40in. × 32in., rapid traverse all ways, fitted with rules and dial gauges.

KERRY 12S Drills.
KERRY Super 8 Bench Drill.
FOBCO ½in. Capacity Bench Drill.
SPEEDAX Abrasive Cutting Off Machine.
QUALTERS & SMITH 6in. Hacksawing Machine.
BEAVER "VBRP" Turret Miller.
RAPIDOR Medium Duty 6in. Saw.
WORCESTER 6 Ton Crank Press.
INVICTA 6M Shaper.
UNION Tool and Cutter Grinder.
CARDIFF 8in. × 60in. Gap Bed S.S. & S.C. Lathe.

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PEGARD Kneeless Type Vertical Miller, 36in. under spindle, Table Travel approx. 4ft.
KEARNS Patent No. 2 Highspeed Surfacing, Boring and Milling Machine. New 1959.
BUFFALO 28U Double Ended Punch, Shear and Angle Cropper.
STIRK Vertical Boring and Turning Miller, 6ft. 1in. swing.
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CRAVEN 19in. × 26in. S.S. & S.C. Lathe.
ASQUITH 6ft. Radial Drill with Screwcutting Attachment.

MACHINES MOTORISED 400/3/50 UNLESS OTHERWISE STATED

The above list is only a selection of the many New, Used and Rebuilt tools available, please call or write for our priced brochure. We will rebuild your own machine tools back to Makers' Specification with 6 months' guarantee.

Members of B.A.M.T.M.

New Victoria V2R Vertical Miller. Rapid traverse all directions. Table size 48in. × 11¼in.—A. FINNEY & CO., Navigation Street, Birmingham 5. Midland 1911.

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NEWALL
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DIVISION

HAVE AVAILABLE FOR EARLY DELIVERY

One NEWALL 'LA' 12in. × 36in. Grinder.

One KEIGHLEY 'XL' 6 by 18 Hydraulic Plain Grinder.

One NEWALL 2436 Jig Borer, fully rebuilt and carrying maker's guarantees.

One NEWALL No. 0 Jig Borer, fully rebuilt and carrying maker's guarantees.

Capacity: 18in. by 12in. Table 14in. Spindle Nose to top of table

One NEWALL 'L1' Internal Grinding Machine, 10in. by 24in. fully rebuilt and carrying maker's guarantees. Maximum Grinding Depth: 12in.

One KEIGHLEY 'KN' Internal Grinding Machine, fully rebuilt and carrying maker's guarantees. Maximum swing over table: 15in. dia.

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BORING MACHINES

WELLMAN RYDER Horizontal Boring Machine. Dia. of Spindle 3in.
RICHARDS 36in. Vertical Boring Machine.
WEBSTER & BENNETT 24in. Vertical Boring Machine.
BULLARD 24in. Vertical Boring Machine.

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KITCHEN & WADE 3ft. Radial Arm Drilling Machine.
PEGARD 4ft. Radial Arm Drilling Machine.
HILLE 4ft. Radial Arm Drilling Machine.

GEAR CUTTING MACHINE

DAVID BROWN MT30 Gear Hobbing Machine (1951).

CAPSTAN AND TURRET LATHES

WARD 2A Capstan Lathe.
WARD 3A Capstan Lathe.
WARD 7 Capstan Lathe. Covered Bed.
WARD 8 Combination Turret Lathe. Covered Bed.
WARD 10/13 Combination Turret Lathe. Covered Bed.

S.S. & S.C. LATHES

SWIFT S.S. & S.C. 9in. by 60in. Gap Bed Lathe.
SWIFT-SENTINEL S.S. & S.C. 9in. by 60in. Gap Bed Lathe.
SWIFT S.S. & S.C. 12¼in. by 90in. Gap Bed Lathe.
SWIFT S.S. & S.C. 27¼ by 90in. Gap Bed Lathe.
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MILLING MACHINES

CINCINNATI No. 2 DIAL TYPE Horizontal Milling Machine.
CINCINNATI No. 3 DIAL TYPE Universal Milling Machine.
CINCINNATI No. 3 DIAL TYPE Vertical Milling Machine.
MILWAUKEE 4H Vertical Milling Machine.

ALL MACHINES OFFERED IMMEDIATELY EX-WORKS,

COWHILL LANE, ASHTON-U-LYNE, LANCS.

Phone: ASHTON 3631. Grams: "HARTOOLS" ASHTON-U-LYNE

American Toolworks Centre Lathe, 19in. Swing, 30in. between Centres. Spindle Speeds 17-600 r.p.m. Excellent condition.
Further details from:—
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Landis 16in. × 48in. Crankshaft Regrinding Machine, 400/3/50.—HICKS MACHINERY, LTD., 26, Addison Place, London, W.11. Tel.: PARk 2333.

HELLER FV120 Vertical Hydraulic Milling M/c. Table 55in. by 15¾in. Long. travel 43in. 30 H.P. Main motor. Rapid and Power Trav. all directions. 18 speeds, 30/1,500 r.p.m. Excellent condition. £2,300.
BOX C.538, MACHINERY, Clifton House, Euston Road, N.W.1.

Automatic. Peterman 7 mm. capacity, complete with four tool slides, screwing attachments, motor drive, 400-440/3/50. Excellent condition. Seen London area.—Telephone: Prospect 8237, or write BOX C505, MACHINERY, Clifton House, Euston Road, N.W.1.

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ACME R. A. GRIDLEY 1¼in. 6-spindle Universal threading 3rd and 4th position, 5th position P.O. slide.
B.S.A. R. A. GRIDLEY 1¼in. 6-spindle 1954 machine, universal threading 4th position, 5th P.O. slide.
Above machines well equipped with gears, cams, collets and feed fingers.

GEORGE TUSTIN LTD.,
NEW STREET, WEST BROMWICH

8in. Centre Dean, Smith & Grace type 4AV m/d all-gd. hollow spindle S.S. & S.C. Toolroom Lathe with taper turning and relieving attachments. Admits 4ft. 3in. between centres. Flanged motor drive, 12 speeds 8-371 r.p.m.—LEE & HUNT, LTD., Crocus Street, Nottingham 'Phone: 84246.

EDWARDS 8ft. × ¼in. Heavy Duty Hand Geared Folding Machine.
SEDGWICKS type C.10 Q.L. 10ft. × ⅛in. Universal Bending and Folding Machine. Motorised 415 volts, 3 phase, 50 cycles, with control gear.
EDWARDS 4ft. × 14g. Power Guillotine. 415 volts, 3 phase, 50 cycles.

R. O. Gray.

4/6, Minerva Road, Park Royal, London, N.W.10
Telephone: ELGar 4841/4842

Classified Advertisements (*PLANT FOR SALE, contd.*)

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ASQUITH 4ft. 9in. Portable Universal Radial Drill. Spindle No. 4 M.T. M.D. 400/3/50.

HUNT No. 3 Universal Twist Drill Grinder. Take ¼in.-3in. Drill. M.D. 400/3/50.

HILMOR Type CI Tube Bender. Non mandrel type. Hand operated for tubes up to 3in. dia.

MILLS 15 ton Hydraulic Straightening Press with rail straightening equipment. M.D. 400/3/50.

EDGWICK Vertical Keyseater. For keyway up to 4in. by ½in. M.D. 400/3/50.

TOWN 4ft. Radial Drill. Model A.E.I. Spindle No. 4 M.T. 9 speeds 40-800 r.p.m. M.D. 400/3/50.

ARCHDALE Sensitive Drill. Cap. 1in. Speeds 450-2,900 r.p.m. M.D. 400/3/50.

EDWARDS No. 3 Circle Cutting Machine. Hand operated for circles from 4in. to 29in. dia. in 16's gauge M.S.

ABWOOD Vertical Spindle Surface Grinder. Table 18in. by 7in. Max. wheel dia. 6in. M.D. 400/3/50.

BROWN & SHARPE No. 2 Plain Miller. Light type. Table 45in. by 10in. Speeds 14-1,300 r.p.m.

RICHARDS PRT2N Horizontal Borer with facing head, traversing spindle, screwcutting. Built 1942.

CHURCHILL H.B.A. Internal Grinder. Swings 12in. inside water guard. M.D. 400/3/50.

STEDALL Plain Horizontal Miller. Table 15in. by 4½in. M.D. 400/3/50.

CARTER & WRIGHT Dual Feed Keyseater. Model No. 4. With canting head. Will cut keyways up to 30in. length by 1½in. width. M.D. 400/3/50.

GISHOLT No. 5 Bar Feed Capstan. Swing over hardened strip bed 19½in. Collet cap. 2½in. With draw-in collet chuck; bar feed; tooling. M.D. 400/3/50.

LANG 8½in. S.S. & S.C. Lathe. Swings over straight V-bed 17in. Admits 48in. between centres. Speeds 19-900 r.p.m. M.D. 400/3/50.

VAN NORMAN 2LP Plain Horizontal Miller. Table 45in. by 10in. 18 speeds 30-1,450 r.p.m. Quick power all ways. M.D. 400/3/50.

CINCINNATI 2/18 Production Miller. Table 36in. by 9in. working surface. Two-way cycle. Speeds 30-1,200 r.p.m. M.D. 400/3/50.

H. BELL (Machine Tools) LTD., Walter Street, LEEDS 4.

Gas Fired Furnaces, 10½in. tempering salt bath, also HSS Tool Hardening Furnaces.—HICKS MACHINERY, LTD., 26, Addison Place, London, W.11. Tel.: PARk 2333.

Hancock Profile Cutter, Capacity 60in. × 40in. Fume Extraction, and large quantity of equipment.—A. FINNEY & CO., Navigation Street, Birmingham 5. Midland 1911.

AH USED MACHINE TOOLS in stock

Cincinnati No. 1/18 Auto Horizontal Milling Machine—Secondhand.

Cincinnati No. 0/8 Vertical Milling Machine—Secondhand.

Gorton No. 8D Vertical Milling Machine —Secondhand capacity 16in. by 10½in. by 13in.

Lees-Bradner Model 8 HT Thread Milling Machine—Secondhand Capacity 12in. dia. by 24in. long.

Asquith Model HDP Profile Milling machine, single spindle, table 36in. by 48in. good working order.

Lindner Type GK Thread, Grinder. Capacity 20in. dia. by 17½in. long, excellent condition.

Kitchen & Wade Hydraulic Honing Machine, capacity up to 9in. bore, very good condition.

Fischer KDM 18/250 Copy Turning Lathe. Very good condition.

Cincinnati No. 5/54 Single Ram Vertical Hydro Broaching Machine. Excellent condition.

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VAN NORMAN No. 3 Universal Miller, table 64in. × 14in., capacity 34in. × 12in. × 17½in., with heavy and light vertical milling attachments.
CINCINNATI 24in. Automatic Duplex Horizontal Milling Machine; table 36in. × 9½in.; 24in. traverse; distance between spindles 7in. to 16in.
RICHMOND No. 3 Universal Miller, table 48in. × 11in., capacity 30in. × 8in. × 16in., speeds 20-1,000 r.p.m. (New.)
PEDERSON Horizontal Miller, table 39in. × 10in., capacity 24in. × 7½in. × 16in.
EDGWICK No. 2 **SIMPLIMILL** Horizontal, Production Milling Machine, table 18in. × 5in. capacity 10in. × 3½in. × 13in. Speed 60-540 r.p.m.
ADCOCK & SHIPLEY 1AD Horizontal Milling Machine, table 19in. × 7in.; capacity 10in. × 6in. × 10in.; speeds 50-2,500 r.p.m.
ARCHDALE 28in. Manufacturing Milling Machine, table 49in. × 13in., capacity 28in. × 8in. × 15½in., spindle speeds 30-462 r.p.m.
B.C.A. Precision Vertical Milling, Boring and Drilling Machine, 8in. dia.
TAYLOR, TAYLOR & HOBSON No. 3 D.S. pantograph Milling and Die Sinking Machine
HERBERT No. 1 Horizontal Milling Machine table 16in. × 4½in.; 7in. lever feed; speed 100-530 r.p.m.
HERBERT No. 1 Horizontal Milling Machine; table 26in. × 8½in.; capacity 10in. × 3½in. × 7in.; speed 100-530 r.p.m.
EDGWICK No. 2 Dial Type Horizontal Miller, table 46in. × 11in.; capacity 25in. × 7in. × 17in.
KENT-OWENS No. 1-14 Production Miller, table 32in. × 9in.; hydraulic feed and rapid traverses.
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HOLROYD Thread Milling Machine; 6in. dia. capacity for internal and external work.
HOLROYD No. 2A Motorised Thread Milling Machine, capacity 4in. × 30in.
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REED PRENTICE No. 5 Vertical Milling Machine, kneeless type, capacity 48in. × 16in. × 15in., table 68in. × 16in., speeds 17-600 r.p.m.

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CERUTI 5ft. 6in. Radial Drilling Machine, spindle No. 5 M.T., speed 30-1,500 r.p.m. (as new).
TOWN 5ft. Radial Drilling Machine; spindle No. 5 M.T.; speed 26-580 r.p.m.
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KITCHEN & WADE 3ft. Radial Drilling Machine; spindle No. 4 M.T.; speed 50-1,500 r.p.m.

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KEMPSMITH No. 2 Universal, 45in. × 10in. £625
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CINCINNATI Model 3-24 Hydromatic Horizontal Milling Machine.
HERBERT No. 5E Capstan, high-speed electric head.
HULLER No. 1 Tapping Machine.

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Acme Gridley Model G, ¼in. Four Spindle Bar Automatic, 400/3/50.—HICKS MACHINERY, LTD., 26, Addison Place, London, W.11. Tel.: PARk 2333.

Hydraulic Drawing Presses, 750 ton Double Action Press by Lake Erie. Bed 146in. × 92in., admitting 72in., with self-contained Pumping Unit.
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GRANOR OF HALIFAX 28in. stroke Heavy Duty Shaping Machine. 400-440/3/50.

EARLY DELIVERY

MITCHELL OF KEIGHLEY 8¼in. Type DM8 Gap Bed Lathe, by 5ft. 3in. B.C. 400-440/3/50. January, 1961 delivery.
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VICTORIA No. 2 Rapidmil Universal Milling Machine, table size 48in. × 11¼in. 400-440/3/50. December delivery.
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EYRE STREET, SPRING HILL,
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NEW MACHINES for EARLY DELIVERIES
DE VALLIERE

HIGH PRECISION TOOLROOM AND PRODUCTION LATHES
10¼in. SWING x 28in. CENTRES
OUTSTANDING VALUE!

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WOODSIDE HILL
CHALFONT-ST-PETER, BUCKS.
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Taylor & Challen B3½ Press, geared, o/front rigid, 60 ton, 4in. str., operators guards, good cond. Also H.M.E. inclinable, adj. stroke, guards. Mot. 20 ton. Good cond.—C. L. THOMAS, LTD., Stirling Road, Solihull. Tel.: 3075-6.

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RUSHWORTH Power Operated Double Geared Open Ended Guillotine Shearing Machine. Motorised for 230/1/50 supply. Capacity 4ft. × ¼in. With automatic sheet hold-down and adjustable front, back and side gauges. Weight approx. 50 cwt.
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FOUR BLACKBURN & CRAWSHAW Rotary Shearing Machines. Motorised for 400/3/50 Supply. Fitted with adjustable gauge. Capacity ¼in. thickness. Cutters 5½in. dia. × ¼in. thickness. Cutting speed 5ft. 6in. per minute. Weight approx. 10½ cwt.
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WARD No. 8

Combination Turret Lathe, with covered bed; 19¼in. swing, 3⅛in. hollow spindle, hydraulically assisted gear change. Ball chuck, fully equipped for chucking.

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D. S. & G. Facing and Boring Lathe, swing 30in. in gap, very good machine.—A. McNAMARA & CO., LTD., New Line, Bacup, Lancs. 'Phone: Bacup 946.

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CINCINNATI 6in. × 26in. Plain Cylindrical Grinder, with Filmatic Bearings, variable hydraulic table traverse, plunge cut grinding, 415/3/50.

MATRIX No. 10 Thread Grinder, 12in. × 14in., 415/3/50, with crushing attachment.

CHURCHILL Model "O" Universal Tool and Cutter Grinder, 415/3/50.

R. D. Gray.

4/6, Minerva Road, Park Royal, London, N.W.10
Telephone: ELGar 4841/4842

Kitchen & Wade Duplex Facing and Centring Machine. Type D.U.P. Swing of saddle 5in. taking 4ft. 0in. between. Condition unused. New 1958. Further details from:—

C. & G. OLDFIELD, LTD.,
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(MACHINERY) LTD.,
79/89, PENTONVILLE ROAD,
LONDON, N.1
Telephone: TERminus 0167/8/9

REINECKER 6in. Straight Bevel Gear Generator. M/D 400/3/50.
ARCEDALE deep hole Drilling Machine. Spindle travel 24in. No. 5 M.T. 18in. throat. M/D 400/3/50.
WICKMAN MOULTON Thread Milling Machine. 10in. Centre height. M/D 400/3/50.
BESCO 36in. light gauge Gang Slitting Machine. M/D 400/3/50.
BENNIE 6ft. × ¼in. Power Guillotine. Geared. Overcrank.

Taylor & Challen No. 3½GDP Double Sided Geared Double Action Cam Drawing Press for sale. Punch stroke 10in., blankholder stroke 5in., between uprights 22in., size of blankholder 12in. diameter. Arranged motor drive 400-440/3/50. Fitted automatic safety guard.—F. J. EDWARDS LIMITED, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham 3.

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OFFER THE FOLLOWING MACHINES

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VOA Jig Borer, 20in. × 15in. Table Movement.
BUTLER 4ft. Double Column Vertical Borer, motor drive, speeds to 44 r.p.m.
SELLARS 5in. Horizontal Boring Machine, cross traverse of table 60in.

GRINDERS

LANDIS Plain Cylindrical Grinder, 6in. × 18in.
HORSTMAN Thread Grinder, capacity 5in. dia. × 9in. b.c.

LATHES, CAPSTANS AND AUTOMATICS

HERBERT No. 20 Comb., spindle bore 7in., speeds 5-201.
WILSON 7¼in. Centre Lathe.
ROLLO 6½in. Centre Lathe.
HERBERT No. 4 Capstan.
Two **CLEVELAND** ⅞in. Model A Single Spindle Autos.
WARD OE Capstan.
BOYES & EMMS S.S. & S.C. Lathe, centre height 16in. × 7ft. 6in.
ACME GRIDLEY 3⅛in. 4-spindle Bar Automatic.
HERBERT No. 9 Combination Turret Lathe.
CHURCHILL-REDMAN Gap Bed Surfacing and Boring Lathe, centre height 12in., distance spindle to turret 55in. Swing in gap 40in.
SWIFT Hydraulic Copying Lathe, 36in. swing × 5ft. 6in. b.c., 30 h.p. drive.

MILLERS

ARCHDALE 28in. Horizontal Miller.
PENSOTTI Thread Miller, capacity 10in. dia. × 13ft.
VICTORIA UI Universal Miller, with vertical attachment.
BROWN & SHARPE No. 2 Vertical Mill, table 54in. × 14in., speeds 30-1,200 r.p.m. Power down feed to head.
HURTH Single Head Keyseater, table 26in. × 9in.
SCHIESS DEFRIES Vertical Keyseater.

PRESSES

30 ton **RASKIN** Double Sided Double Geared Drawing Press. Area 20in. × 23in. Draw 4½in.

SLOTTERS, SHAPERS AND PLANERS

NEWEY 14in. Shaper.
ALBA 12in. Shaper.
MAXICUT High Speed Gear Shaper, max. dia. 7in. × 2in. face.
POREBA Model HDA.80 Planer, capacity 10ft. × 32in. × 30in. table, drive by Heid gearbox.

MISCELLANEOUS

6in. Power Hack Saw.
MORGAN 4ft. × ¼ Overcrank Guillotine.
CIRCULAR Graduating Machine for English, metric and degree graduations.

Visitors always welcome

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172/178, Victoria Road, Acton,
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THE SPOT ● TO WATCH!

FOR GOOD CLASS SECONDHAND MACHINES AT LOW COST

BROWN & SHARPE 2G 8000 series Automatics.
RYDER WELLMAN Hor. Borer 3in. Sp.
UNION Hor. Borer 3in. dia. Sp.
KEARNS No. 2 Hor. Borer. 3in. Sp. Facing Head.
TIMBRELL & WRIGHT Capstan.
HERBERT 2D Capstan.
JONES & SHIPMAN H/Spd. Bench Drill.
ARCHDALE Drilling Machine.
RABOMA 4ft. 6in. Radial Drill.
CHURCHILL No. 1 Planetary Grinder.
BROWN & SHARPE No. 5 Plain Grinder.
LANDIS 14in. by 48in. Uni. Grinder.
MATRIX No. 2 Gear Shaper.
DRUMMOND MAXICUT No. 2 Gear Shaper.
TRIUMPH Centre Lathe.
WARNER & SWASEY Turret Lathe. 2A.
DENBIGH Horiz. Mill.
ADCOCK & SHIPLEY No. 0 and No. 1 Hor. Mill.
CINCINNATI No. 4 Hor. Mill.
CINCINNATI 4/48 Simplex Hydromatic Mill.
CINCINNATI 45/60 Simplex Hydromatic Mill.
EDGWICK Simplimill.
MILWAUKEE Simplex 12/24 Mill.
ADCOCK & SHIPLEY No. 3 Plain Mill.
PARKSON 2T Universal Mill.
KELLER 1210 Diesinking Machine.
CINCINNATI HYDROTEL 28in. Vertical.
MOREY PROFILE MILL.
TAYLOR & CHALLEN 1½ B. Press.
MORGAN Bender.
ATLAS 6in. Shaper.
GISHOLT Super Finisher.
MICROFLAT Honing Machine.
NEWALL Hydrolap.
KITCHEN & WADE No. 2 Honing Machine.

LATE AMERICAN MACHINES

GLEASON 12in. Str. Bevel Gear Generators.
GLEASON 3in. Str. Bevel Gear Generators.
FELLOWS 7125 High Speed Gear Shaper.
FELLOWS 72 High Speed Gear Shaper.
FELLOWS No. 7 High Speed Gear Shaper.
FELLOWS 75A High Speed Gear Shaper.
FELLOWS 61A Gear Shaper.
HEALD 72A3 Internal Grinder.
GLEASON No. 16 Spiral Bevel Hypoid Gear Generator.
K & T 5H Plain Mill.

All machines motorised 400/3/50 unless otherwise stated.

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PHONE EDGWARE 4488/9

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Kitchen & Wade 6ft. Universal Portable Radial Drill, new 1951. New condition.
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COVMAC 13in. Swing Gap Bed Lathe, by 3ft. 3in. b.c. 400/3/50.
COVMAC 17in. Swing Gap Bed Lathe, by 5ft. 0in. b.c. 400/3/50.
DENHAM 6in. Gap Bed Lathe by 2ft. 3in. b.c. 400/3/50.
GRANOR OF HALIFAX 18in. × 28ft. b.c. A.G.H. Gap Bed S.S. & S.C. Lathe. 400/3/50.
D.S. & G. 7in. CH by 4ft. 0in. b.c. Straight Bed Lathe. 400/3/50.
BARDONS & OLIVER No. 3 Universal Turret Lathe. 400/3/50.
GISHOLT No. 5 Universal Turret Lathe. 400/3/50.
WARNER & SWASEY 1A Turret Lathe. 400/3/50.
KELLY 28in. Stroke Heavy Duty Shaping Machine with swivelling table. 400/3/50.
NOBLE & LUND 11in./16in. Hydraulic Cold Sawing Machine. 400/3/50.
NOBLE & LUND 20/22in. Fluifeed Cold Sawing Machine with hydraulic swivel vice. 400/3/50.
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WE UNDERTAKE REBUILDING OF ALL TYPES OF MACHINE TOOLS

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BIRMINGHAM, 18
Tel. EDGbaston 1118 & 1119 'Grams Capstan, Birmingham

AUTOS
CONOMATIC 1¼in. 8 spindle. Type W.W.

BORING
KEARNS No. 2 Boring and Facing.

DRILLING
ASQUITH 4ft. 6in. O.D.1 Radial Drill.
PROGRESS 5E. Round table.

GRINDING
COVEL 24 × 7 Hydraulic Surface Grinder.
CHURCHILL 8 × 36in. Plain. Hydrauto bearings.

LATHES
WARNER & SWASEY No. 2A Long bed.
SOUTHBEND 16in.
EDGWICK 7in.
DEAN, SMITH & GRACE. Height of centres 7in.
WARNER & SWASEY No. 5 Preselector.

MILLING
20in. **ARCHDALE** Plain Mill. Rapid.
18in. **EDGWICK** Production Mill
VICTORIA U4 Universal, slightly used.
MILWAUKEE 2E Plain.

SHAPING
24in. **CHURCHILL REDMAN** Heavy Duty.
19in. **TOWN** Heavy Duty.

SHEET METAL
GUILLOTINES
EDWARDS 6ft. × ⅛in. Overcrank.
EDWARDS 8ft. × ¼in. Overcrank.
FOLDERS
MORGAN 6ft. × 14g. Universal.
EDWARDS 6ft. × ¼in. Swing beam, hand geared.
EDWARDS 6ft. × 14g. Open ended.
EDWARDS 6ft. × 16g. Open ended.
"ELDAIR" NEW PRESS BRAKES
6ft. × 12g. between column. Delivery 10 weeks.
6ft. × ⅛in. between column. Delivery 3 weeks.
10ft. × ⅛in. between column. Delivery 1 week.

All machines motorised 400/3/50 cycles.

STANCROFT LTD.
BEDWORTH ROAD, COVENTRY.
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Harry Kirk

can recommend the following modern quality machines from STOCK

AUTOMATICS

BULLARD 8in. Mult-au-Matic, 6 spindles, type D.

RYDER Verticalauto, capacity 16in., swing × 8in., 6 spindles.

BORING MACHINES

RICHARDS 36in. Vertical Boring Mill, complete with side head.

JONES 6in. Spindle Horizontal Borer. Table 17ft. 6in. × 8ft. Spindle travel 48in. Rapid traverse 84in. per min. Motorised 400/3/50. Weight 70 tons.

SCHARMANN 3in. Sliding Spindle Horizontal Boring Machine, equipped with facing head and screwcutting.

BULLARD 36in. Vertical Boring Mill.

KITCHEN & WADE Vertical Fine Boring Machine, 14in. stroke. Compound table.

SCHIESS Vertical Boring Mill, 39in. dia. of table. Maximum swing 48in. S.C.M.D. 35 h.p., 400/3/50.

DRILLING MACHINES

POLLARD Model 3KX 3ft. Radial Drilling Machine.

GRINDING MACHINES

BROWN & SHARPE 6in. × 18in. Horizontal Spindle Surface Grinding Machine complete with magnetic Chuck and Dust Extractor.

PRECIMAX Universal Grinder, capacity 12in. × 72in.

HEALD No. 172 Gap Bed Internal Grinding Machine, maximum diameter of component 36in.

BILLETER Hydraulic Open-side Slideway Grinding Machine, capacity 47in. × 12in.

LATHES

NOBLE & LUND Heavy Duty Centre Lathe, 22in. centre height × 29ft. between centres. Max. swing over saddle 33in. dia.

HARVEY Heavy Duty Centre Lathe, 42½in. centre height × 52ft. between centres. Max. swing over saddles 65in. dia.

CHURCHILL-REDMAN S.S. & S.C. Centre Lathe, 7½in. centre height × 4ft. 6in. between centres.

DENHAM S.S. & S.C. Gap Bed Centre Lathe, 15½in. centre height × 12ft. 6in. between centres. Swing 54in. in gap, complete with Taper Turning Attachment, Faceplate, Chucks, etc.

CRAVEN S.S. & S.C. Centre Lathe, 13½in. centre height × 65ft. between centres.

CRAVEN S.S. & S.C. Centre Lathe, 13½in. centre height × 3ft. 6in. between centres.

WERMELINGER Centre Lathe, Model MJ8, 6in. centre height × 32in. between centres.

HERBERT No. 11 Combination Turret Lathe.

MILLING MACHINES

BROWN & SHARPE No. 3 Vertical Milling Machine.

ARCHDALE 30in. Vertical Milling Machine.

COLLET & ENGLEHARDT Keller Type Die Sinking Machine. Model FKf 80, capacity 60in. × 30in.

PLANING MACHINES

ORMEROD 24in. Heavy Duty Shaping Machine.

CLEVELAND Openside Planing Machine, capacity 10ft. × 2ft. 6in.

CINCINNATI Planing Machine, capacity 8ft. × 2ft. 6in.

MISCELLANEOUS MACHINES

SUNDERLAND No. 11 Gear Planer. Max. capacity 74in. dia. Max. stroke 9in. face. S.C.M.D. 400-440/3/50.

CLIFTON & BAIRD Cold Circular Saw.

Hydraulic Vertical Internal Honing Machine (manufactured by **PETER WOLTERS**). Capacity 0.2in. to 2in.

RAPIDAN Double Helical Gear Generating Machine, 12in. diameter capacity.

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'Phone:
WALSGRAVE-ON-SOWE 2253 (6 lines)

Newman

AUTOMATICS

BULLARD Multi-Au-Matic 7in. 8 spindle.
BULLARD Multi-Au-Matic 12in. 6 spindle.

BORING MACHINES

KEARNS No. 4 Horizontal Boring and Facing Machine, 4in. diameter travelling spindle.
WEBSTER & BENNETT Vertical Boring Machine, table 50in. diameter.
RICHARDS Type PRT Horizontal Floor Boring Machine, 3½in. travelling spindle, 28in. diameter facing head.
ASQUITH Horizontal Floor Boring Machine, 7in. diameter travelling spindle.
GIDDINGS & LEWIS No. 45 Horizontal Boring Machine, 5in. diameter travelling spindle.

CAPSTAN AND CENTRE LATHES

HERBERT No. 12 Combination Turret Lathe, 6½in. diameter hollow spindle.
NILES Heavy Duty Centre Lathe, S.S. & S.C., 17in. centre height × 28ft. between centres.
U.L.R.O. Heavy Duty Centre Lathe, 16in. centre height × 30ft. between centres.

DRILLING MACHINES

HETTNER Radial Drilling Machine, 10ft. elevating arm.
TOWN Radial Drilling Machine, 4ft. 6in. elevating arm. (NEW.)
TOWN 30in. Single Spindle Boring and Drilling Machine.

GEAR MACHINES

ORCUTT Model HM24 Hydraulic Internal Gear Grinder.
GLEASON 3in. Straight Bevel Gear Generator

GRINDING MACHINES

LANDIS Plain Hydraulic Cylindrical Grinding Machine, 18in. swing × 72in. between centres
ORCUTT Model HM24 Internal Spur Gear Grinding Machine.
CHURCHILL Crankshaft Grinding Machine, 26in. swing × 84in. between centres.
CHURCHILL Turret Type Hydraulic Universal Grinding Machine, 16in. swing × 50in. between centres.
CHURCHILL Plain Hydraulic Cylindrical Grinding Machine, 20in. swing × 72in. between centres.
BROWN & SHARPE Plain Cylindrical Grinding Machine, 10in. swing × 36in. between centres.
B.S.A. LANDIS Plain Cylindrical Grinding Machine, 6in. swing × 30in. between centres.
T.O.S. Vertical Spindle Hydraulic Surface Grinding Machine, table working surface 118in. × 24in. (NEW.)

MILLING MACHINES

CINCINNATI Model 5/72 Plain Hydromatic Milling Machine, table 91in. × 22in.
CINCINNATI 1/18 Automatic Manufacturing Milling Machine.
CINCINNATI No. 2L Plain Horizontal Milling Machine, table 52in. × 10in.
CINCINNATI No. 1M Vertical Milling Machine.
CINCINNATI No. 4 Dial type Horizontal Milling Machine.
GRAFFENSTADEN Model FI1101 Plain Horizontal Milling Machine, table 52in. × 10in.
TECHNOIMPEX Universal Horizontal Milling Machine, table 59in. × 16in. (NEW.)
SUNDSTRAND Hydroscrew Rigid Mill Horizontal Production Milling Machine, table 78in × 14in.
PRATT & WHITNEY Model BL3620 3-spindle "Keller" Die Sinking Machine.
CENTEC Model 3R Automatic Production Milling Machine, table 25in. × 16in.

PLANING MACHINE

SUMMERSKILL Double Column Planing Machine, capacity 16ft. × 5ft. × 5ft. Four toolboxes.

NEWMAN INDUSTRIES LIMITED,
Machine Tool Division: YATE, BRISTOL
Tel.: Chipping Sodbury 3311. Telex. 44121.
Cables: "Dynamo Yate."
London Office: Terminal House, Grosvenor Gardens, S.W.1. Tel.: Sloane 8206.
Telex. 23289.

Kearns Model O.C. Horizontal Boring Machine, 3in. dia. traversing spindle, 16 spindle speeds 18-725 r.p.m. Revolving table 42in. × 36in. Spindle to steady 7ft. 6in. Verniers. 7½ h.p. 400/3/50 motor.—LEE & HUNT, LTD., Crocus Street, Nottingham. 'Phone 84246.

Churchill 12in. × 36in. Universal Grinder. Hydraulic Stroke. Internal Attachment. Complete Machine. Full details from:—

C. & G. OLDFIELD, LTD.,
15, Abercorn Street,
PAISLEY.

Power Press. Ratzer 12 tons. 1½in. stroke. Inclinable. Few months use. Redundant. Cost £197 0s. 0d. Space urgently required. £70 0s. 0d. View Brighton.—BOX C504, MACHINERY, Clifton House, Euston Road, N.W.1.

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C.M.C. Heavy Duty S.S. & S.C. Lathe, swing 30in. over bed, 6ft. between centres, 400/3/50.—A. MCNAMARA & CO. LIMITED, New Line, Bacup, Lancs. 'Phone: Bacup 946.

Drummond No. 0 Hydraulic Multi-tool Lathe. Mot. Good condition Also Edgwick 9in. Multi-tool Lathe, heavy duty Ex. condition.—C. L. THOMAS, LTD., Stirling Road, Solihull. Tel.: 3075-6.

1,000 Ton 'Eumuco' Knuckle Joint Coining and Sizing Press, steel plate construction, 2in. stroke, 31in. between sides with 40 h.p. motor drive.

REED BROTHERS (ENGINEERING) LTD.,
Replant Works,
Woolwich Industrial Estate,
London, S.E.18.
Tel.: Woolwich 7611 (6 lines).

Archdale 2 Spindle Drilling and Boring Machine. A.G.H. No. 5 M.T. spindles. Ind. motors.—WILCOX & CO., Barr Street, Birmingham 19. NORthern 1234/5.

Osmond Abrasive Cut-off Machines, models C16/15 and 0/10, to cut 2in. × 1½in. steel bar or 3in. and 1½in. tube respectively.—A. FINNEY & CO., Navigation Street, Birmingham 5. Midland 1911.

Classified Advertisements (*PLANT FOR SALE, contd.*)

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LEEDS 63-7398

HERBERT No. 2S Capstan Lathe, with bar feed, 415/3/50.

HERBERT No. 4B Capstan Lathe, with bar feed, 415/3/50.

WARD No. 2A Capstan Lathe, with bar feed, 415/3/50.

DRUMMOND Model K Capstan Lathe, arranged for chucking, 415/3/50.

GISHOLT No. 4 Capstan Lathe, arranged for chucking, 415/3/50.

R. V. Gray

4/6, Minerva Road, Park Royal, London, N.W.10

Telephone: ELGar 4841/4842

Keller Diesinking and Profiling Machine Model GG1210. Actual die size 12in. × 10in., seen working.—A. FINNEY & CO., Navigation Street, Birmingham 5. Midland 1911.

Blacker Type B Power Forging Hammer for sale. With travelling type arm. Motor driven 400-440/3/50. Treadle control blow. Length of arm 20in. Length of travel 18in.—F. J. EDWARDS LIMITED, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham 3.

Van Norman No. 2S Horizontal Miller, 50in. × 12in. table. Power feeds and rapids all ways, rebuilt. £700.—A. McNAMARA & CO., LTD., New Line, Bacup, Lancs. 'Phone: Bacup 946

Brown & Sharpe No. 2 Auto- matic, int., high speed, pressure lubrication, gears, bar stands, stock tube. Good condition.—C. L. THOMAS, LTD., Stirling Road, Solihull. Tel.: 3075/6.

Landis 10in. × 24in. Type "C" Universal Grinder. Internal Attachment. New condition.

Further details from:—
C. & G. OLDFIELD, LTD.,
15, Abercorn Street,
PAISLEY.

SALES ENTERPRISE LTD.

EX STOCK

New **BINNS & BERRY** 12½in. T.B. Lathe Mk. III, 7ft. 6in. b.c., 46in. swing in gap, 16 spindle speeds 12-600 r.p.m., 4¼in. hole through spindle, quick return to saddle, 15 h.p. motor. Weight approx. 4¼ tons.

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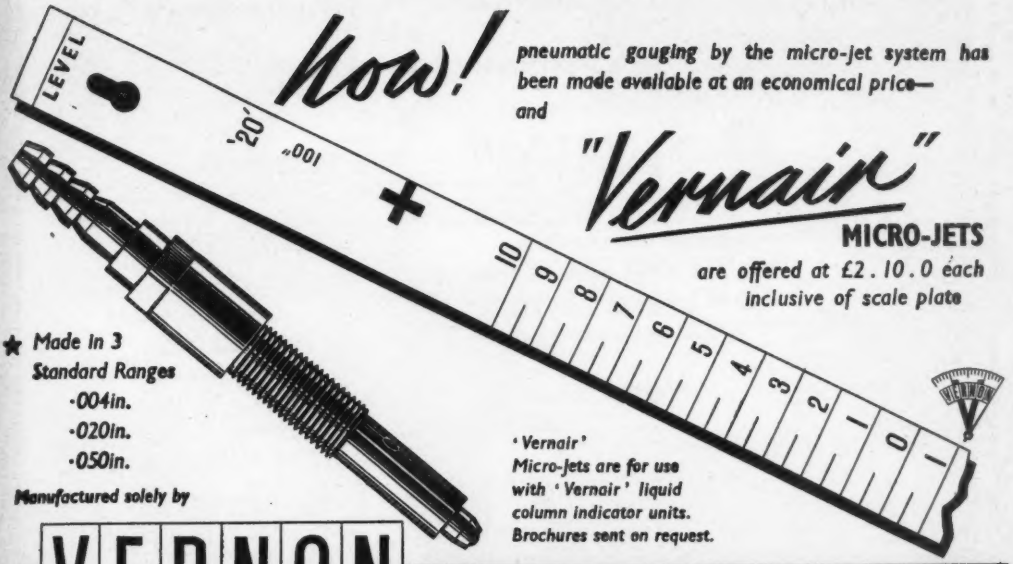

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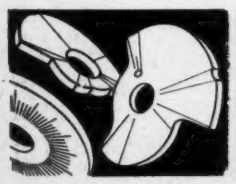

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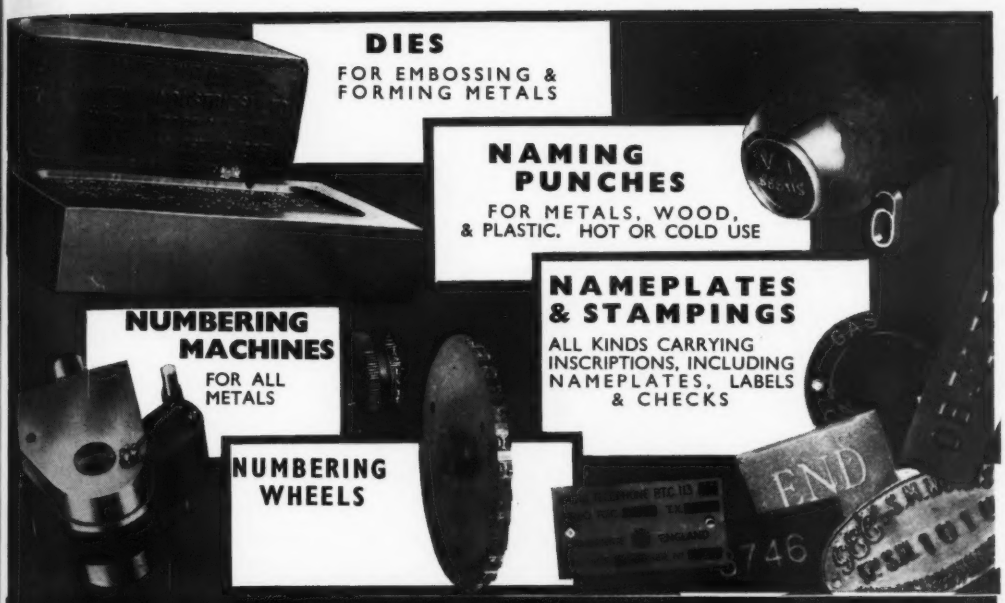

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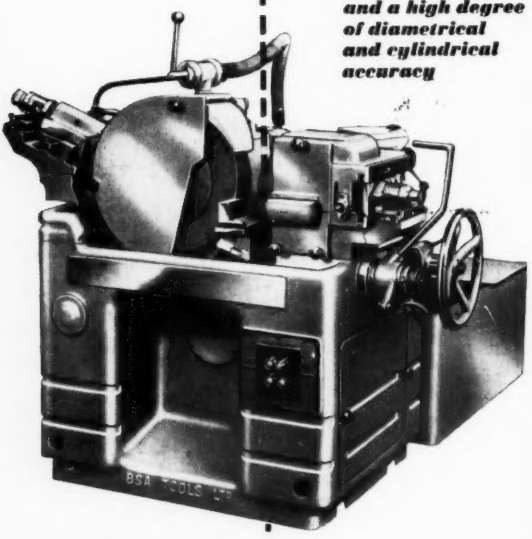

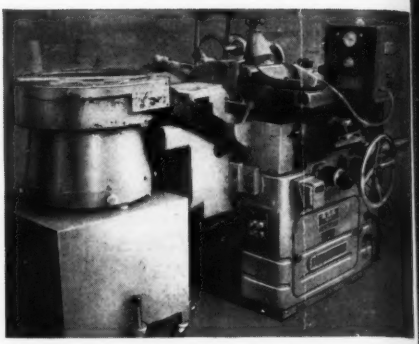

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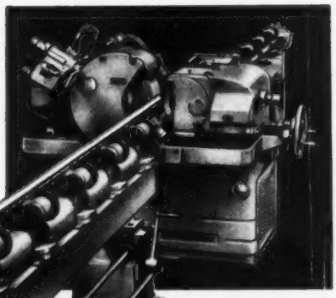

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